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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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See Advertisement page 52. 4920

Improved High Pressure
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See our Advertisement in last week's issue, page 20.
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See half-page Advertisement, last and next week.

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ESTABLISHED 1810.
CAPITAL (Fully Paid) - - $6,000,000
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This Bank receives Accounts of Banks, Bankers, Corporations, Firms and Individuals on favourable terms, and grants to its depositors every facility consistent with prudent and conservative banking methods.
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High-class GUNMETAL STEAM FITTINGS.
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See Full Page Advt. page 44, Sept. 23.

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MONOMETER MANUFACTURING CO., LTD.,
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See Advertisement page 48, Sept. 29.

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See Advertisement page 37, Sept. 29. 9402

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5486
See half-page Advertisement page 62, Oct. 6.

The Manchester Steam Users' Association.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam. 9, Mount Street, Manchester.
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Founded 1854 by Sir W. Fairbairn.
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Aeroplanes and Airships. Construction, Design and Draughtsmanship. Complete Postal Courses. Also preparation for Exams. of Institutions of Civil, Mechanical and Electrical Engineers.—Pemmingtons, 264, Oxford Road, Manchester. 5397

TENDERS.

India Office, Whitehall,
12th October, 1916.

The Secretary of State for India in Council is prepared to receive

Tenders from such

Persons as may be willing to supply:—
(1) DOG SPIKES;
(2) FISHBOLTS.

The Conditions of Contract may be obtained on application to the Director-General of Stores, India Office, Whitehall, S.W., and Tenders are to be delivered at that Office by *Two* o'clock p.m. on Tuesday, the 24th October, 1916, after which time no Tender will be received. F 269

G. H. Collier,
Director-General of Stores.

Great Northern Railway Company (Ireland).

Contracts for General Stores.

The Directors of the Great Northern Railway Company (Ireland) are prepared to receive

Tenders for the Supply of the

undermentioned STORES for Twelve Months, from the 1st January to the 31st December, 1917.

	No. of Form.		No. of Form.
Axles and Tyres (Steel)	1	Iron Plates, Bars, Angles, Tees and Forgings (best Staffordshire and Yorkshire)	27
Baskets, Brooms, Brushes, Mats and Sponges	2	Lamps (Oil) and Brass Carriage Fittings, Oiler Pads, and Enamelled Iron Plates	28
Bolts and Nuts, Studs, Pins, Rivets and Washers	3	Lead (ground in oil and dry), Sheet, &c.	29
Boxes (Farm & Market Produce)	4	Leather and Leather Goods, and Balata Belting	30
Brass and Copper Sheets, Plates, Tubes & Wire, Block Tin, Zinc, Spelter and Patent Metal	5	Nails	31
Buckets, Oil Cans, Zinc Sheets, Galvanized Iron Sheets, Emery, &c.	6	Oil (Creosote)	32
Buffers & Axle Guards for Carriages and Wagons, Wagon Hinges, Barrow Frames, &c.	7	Oils (Burning, Lubricating, &c.)	33
Canvas and Tarpaulin Wagon Covers	8	Plates (Steel Boiler), Steel Forgings, Fish Plate Liners, Cast Steel Engine and Tender Wheel Centres, Roof Bars and Mild Steel Plates, Bars, Angles, Tees, and Channels	34
Castings (Ordinary Iron), Firebars, Forgings, Crucibles, Cylinders and Buffer Stops	9	Rope, Twine, Flax and Hemp Gaskin	35
Cement, Plaster of Paris, Slates, Glazed Ware Pipes, Fire Bricks, Tiles, &c.	10	Screws (Iron & Brass), Split Pins, &c.	36
Chain	11	Signalling Materials	37
Colours, &c. (ground in oil and dry) and Hall's Distemper, Wall Paper, &c.	12	Springs for Engines, Carriages, Wagons, &c.	38
Drysalteries	13	Tin Plates	39
Electrical Fittings, Lamps, &c.	14	Timber, White American Oak Scantlings, St. John's Spruce Plank, Logs, Planks, Boards, Mouldings, Sheetings, &c.	40
Electric Cable & Wire	15	Transfers (Carriage, &c.)	41
Electric Light Carbons	16	Tools (Edge), Saws, Files, Tool Steel, Carriage Keys, Hammers, Shovels, Spades, &c.	42
Explosives, Fog Signals and Carbide of Calcium for Acetylene Gas Lighting	17	Tubes and Fittings (Iron), Wire, Wire Work, Panel Pins, Staples, and Point Rodding	43
Fittings (Brass) for Gas and Water, Gas Burners, Gunmetal Steam Unions, Rain Water Pipes, &c.	19	Tubes (Steel—Galvanized), Cold Drawn Weldless for Bi lers	44
Gas Mantles	21	Upholstery for Carriages, Curled Hair, Blinds, Rugs, Linoleums, Tape and Soft Goods	45
Gauges (Steam and Vacuum Brake)	22	Varnishes, Enamel, Black Lacquer, and Sheet Dressing Composition	47
Glass	23	Waste (Cotton), Wick, Sponge Cloths, &c.	48
Hammer, &c., Handles, Barrows, Oak Keys, Loading Boards and Scotches	24		
Hinges (Wrought Iron and Brass), Locks and Keys, Hardware (Iron and Brass), Closet Basins and Seats, &c.	25		
Indiarubber Goods, Loco. Packing, Asbestos, &c.	26		

Forms of Tender can be obtained from the Secretary on payment of One Shilling for each form. *Please do not send Stamps.*

Tenders must be for the supply of Goods in accordance with the Company's patterns; these patterns may be seen at the General Stores Depot, Dundalk (they cannot be sent away for inspection), between the hours of Ten a.m. and Four p.m., on each week-day except Saturdays.

Tenders (made out on the Company's forms), should be delivered, under sealed cover endorsed "Tender for Stores," to the undersigned, not later than Ten a.m., on the 2nd November, 1916.

The Directors do not bind themselves to accept the lowest or any Tender.

T. Morrison, Secretary.

Secretary's Office, Amiens Street Terminus, Dublin, 5th October, 1916. F 215

APPOINTMENTS OPEN.

Dublin Port and Docks Board.

Appointment of Civil Engineer.

The Board are open to receive

Applications from Fully

qualified Civil Engineers for Position of CHIEF ENGINEER for the Port of Dublin.

Applicants must have experience of Port works, and be able to undertake the control and management of the property of the Board, including dredging plant, electrical plant, steam plant, and buildings, &c., the preparation of plans in connection with new works, and for Parliamentary and other purposes.

While not prepared to place any age limit for applicants, preference will be given, other things being equal, to candidates between 40 and 50 years of age.

Recognising the importance of the position, the Board are desirous of obtaining an engineer of undoubted position and experience; and, for convenience, applicants are invited to state the salary they are prepared to accept.

Applications to be sent in sealed envelope, addressed to Secretary, by 26th October next, and endorsed on cover "Engineering Appointment."

By Order,
N. Proud, Secretary.

Port and Docks Board Office, Dublin,
6th October, 1916. F 237

Halifax Education Committee.

Municipal Technical College.
Principal—J. Crowther, B.Sc.

Applications are Invited for

the POST of ASSISTANT in the Mechanical Engineering Department. Salary £175 per annum. Candidates must be ineligible for military service. Teaching experience, including laboratory work, and practical experience in an engineering works, essential.

Particulars and forms of application, to be returned as early as possible, may be obtained from the Principal. F 201

W. H. Ostler,
Secretary.

The Cable Makers' Association invites

Applications for the Post of

Secretary. An energetic man with first-class commercial experience and some knowledge of electrical matters and accountancy is required. A liberal salary will be paid to a suitable man.—Applications, which must be in writing, to be addressed to Cable, care of Messrs. Claremont, Haynes & Co., Vernon House, Sicilian Avenue, Bloomsbury, London. F 255

Wanted, by a Large Engineering

Firm, MANAGER for proposed new branch dealing in oil milling machinery. Must have good experience and connection, and be competent to take charge of department.—Address, F 131, Offices of Engineering.

Messrs. Stewarts & Lloyds,

Ltd., INVITE APPLICATIONS for position of MANAGER for their London office. Applicants must be between 35 and 45 years of age and have good commercial experience.—Apply, with full particulars, to SECRETARY, 41, Oswald Street, Glasgow. F 247

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Important Firm of rolling stock builders, a thoroughly efficient GENERAL MANAGER, with first-class experience. Good salary would be paid with a share in the profits.—Apply, in confidence, to X.Y.Z., care of Rawle, Johnstone, Gregory & Company, Solicitors, 1, Bedford Row, W.C. F 224

Machine Tools.—General

MANAGER for leading Works in North of England. Must be thoroughly practical and have good commercial experience; good organiser, strict disciplinarian, and capable of getting maximum output of high grade machine tools. No one on Government work engaged without permission of present employers.—Applications, in strict confidence, giving full particulars of experience, qualifications, salary, &c., to F 257, Offices of Engineering.

Works Manager Wanted, for

modern and progressive seamless steel tube works near Birmingham. Under Government control on War work. Position is a responsible one and offers excellent prospects for an engineer who is a good organizer and tactful manager. Actual experience in tube works not absolutely necessary. Steam and electric driven mills, fitting shops, gas furnaces, &c.—Address, stating experience, age, and salary required. F 212, Offices of Engineering.

Assistant Works Manager

REQUIRED, for small engineering firm in London district. Marine experience essential. No person resident more than 10 miles away, or engaged on Government work need apply.—Address, stating age, experience, and salary required; F 217, Offices of Engineering.

To Disabled Officers.—

WANTED, a GENTLEMAN, under 27 years, disqualified for military service, single, with public school education and three years' engineering experience as Engineer Assistant Manager on tea estate in Assam, to qualify for tea planter's career. Preference to officers returned from the front unfit for further military service.—Address, "Assam," Wm. Pontrous & Co., Glasgow. F 171

Junior Inspecting Engineer,

age 21 to 25, WANTED by large firm of general engineers in the Midlands. To inspect small iron and steel forgings, malleable and grey iron castings, munitions of war. Must have previous shop experience. Ineligible for army preferred. No person already on Government work will be engaged.—Apply, giving full particulars, experience, age, salary required, to your nearest LABOUR EXCHANGE, mentioning this Journal and F 188.

Wanted, Fully Qualified Man,

to take charge of estimating department in engineering firm; speciality high-speed engines, circulating pumps and air compressors. No person already employed on Government work will be engaged.—Apply, your nearest LABOUR EXCHANGE, mentioning this Journal and F 235.

Chemical Engineer Required,

at once; must be thoroughly experienced and have sound education, and knowledge of high pressure gas plant. Liberal wages to first-class man. No person employed on Government work will be engaged. Write stating fully qualifications and details of experience.—Apply to your nearest LABOUR EXCHANGE, mentioning this paper and R 637

Chemical Engineer Required,

with practical experience of Nitric Acid, Sulphuric Acid Concentrating, Acid Mixing and Denitrating Plants. Must be good mechanical engineer, with some knowledge of Electrical Plant, and capable of handling men with tact. Please state age and full particulars of experience. Applications can be made in writing through your nearest LABOUR EXCHANGE, mentioning this Journal and R 865. No person engaged on Government work will be employed.

Engineer Required, as Head

of inspection department in aeroplane works. Must have had a good mechanical engineering works training, tool room experience, and preferably knowledge of aeroplane work. No one on Government work will be engaged.—Apply in writing, stating age, and salary required, to your nearest LABOUR EXCHANGE, and quote No. A 2336. F 271

Engineering Assistant.—

WANTED at once for a temporary appointment, an Engineering Assistant for bridge work. Only men of large experience need apply.—Applications, stating salary required, to be sent to Mr. H. T. Wakelam, M.Inst.C.E., County Engineer, Guildhall, Westminster, S.W. F 233

Rate Fixer, for Bench Filing

and fitting. Good prospects for a live man with experience. Apply in writing, giving full details of past experience and wages required. No one on Government work need apply.—Apply, your nearest LABOUR EXCHANGE, mentioning this Journal and F 238.

Wanted, Ratefixers, or Intelli-

gent Practical Fitters and Turners, to train as such. Men with initiative and tact required. State particulars of age, experience, &c. No one already on Government work will be engaged.—Apply, your nearest LABOUR EXCHANGE, mentioning No. A 2412. F 246

Chief Draughtsman.—An Old

established firm of Manchester engineers, manufacturing high-speed vertical steam and gas engines, condensing plants, and air compressors, REQUIRE the SERVICES of a fully qualified and competent GENTLEMAN, to take charge of their drawing office. No person on Government work can be engaged.—Reply, stating age, experience, and salary required, to your nearest LABOUR EXCHANGE, mentioning this Journal and No. G 510. F 249

Wanted, Three Draughtsmen

thoroughly conversant with either Blast Furnace or Steel Works practice, for large Government controlled Iron and Steel Works on the North West Coast. Permanency to suitable men.—Applications should be forwarded to the nearest LABOUR EXCHANGE, quoting No. A 2322. Draughtsmen already engaged on Government work cannot be engaged. F 47

Draughtsmen (Senior and

Junior), for urgent Government aeronautical work. Must have had several years shop and D.O. experience, also some technical training; men used to automobile work preferred. Good salary and prospects; overtime paid for. No man on Government work can be engaged.—Write or apply in first instance, to your nearest BOARD OF TRADE LABOUR EXCHANGE, mentioning this paper and No. A 2390. F 175

Wanted, a Good Shop

DRAUGHTSMAN for designing special tools and machinery devices for Manchester Works. Must be shop-trained; drawing office technique not essential. Permanent job and good opening. Apply, giving full particulars of experience, &c. No person on Government work will be engaged.—Apply, your nearest LABOUR EXCHANGE, quoting No. A 2386. F 181

Jig and Tool Draughtsman

REQUIRED for motor and aero work. No person on Government work will be engaged. Only men experienced in latest methods and held similar posts need apply.

Apply, your nearest LABOUR EXCHANGE, quoting No. A 2227. F 182

Draughtsman Wanted, for

ships auxiliaries. No one engaged on Government work will be employed.—Apply, to your nearest LABOUR EXCHANGE, mentioning this Journal and F 196.

Draughtsman for Steel Struc-

tural Work REQUIRED in engineer's office in Westminster; must be ineligible for the Army.—Write, stating experience, references, age and wages required, to F 243, Offices of Engineering.

Draughtsman Required, by

controlled establishment. A knowledge of internal combustion engines would be an advantage. Marine engine experience required. No person already employed on Government work will be engaged—Apply giving full particulars to your nearest LABOUR EXCHANGE, quoting No. A 2422. F 229

Draughtsman Required, for

large controlled engineering works in Midlands, manufacturing all kinds of constructional steelwork. Preference given to man having experience of works plant.—State in confidence age, experience, and salary required, to your nearest LABOUR EXCHANGE. No one already engaged on Government work need apply. Mention this Journal and F 232.

Good Draughtsman Wanted,

with automobile or aero engine experience by controlled firm in the Midlands. No person engaged on Government work need apply.—State age, experience, and salary required, to nearest LABOUR EXCHANGE, mentioning this Journal and F 242.

Efficient Structural Draughts-

MAN WANTED who can act as assistant foreman. No person already employed on Government work will be engaged.—Apply, nearest LABOUR EXCHANGE, mentioning this Journal and F 251.

Foundry Foreman Wanted,

with good all-round experience in general engine castings, plate moulding, brass and malleable iron. No person already engaged on Government work will be employed.—Apply your nearest LABOUR EXCHANGE, quoting Engineering and F 241.

Foreman Wanted, for Machine

and fitting shop of controlled establishment. A good and permanent position for a progressive man with organizing abilities. No person already on Government work will be engaged.—Apply, giving full particulars to your nearest LABOUR EXCHANGE, mentioning No. A 2421. F 228

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on direct important munitions; experience in Engineers' small repetition work; good prospects for ambitious and capable man.—Apply, stating fully experience, age, salary expected, to F 261, Offices of Engineering. Men engaged on Government work, or residing more than 10 miles away will not be engaged

Machine Shop Foreman for

small shop on accurate high-class work in brass and ebonite. Good and permanent position for capable man. No person already employed on Government work will be engaged.—Apply, nearest LABOUR EXCHANGE, mentioning this Journal and F 244

General Foreman Wanted,

ineligible for military service, for Engineering Works at Greenwich; one having good experience in light structural steel work and well up in latest machine shop practice; must be energetic, strict disciplinarian and Six o'clock man. Permanency and progressive position to suitable man. No one at present on Government work need engage.—Apply to nearest BOARD OF TRADE LABOUR EXCHANGE, mentioning Engineering and F 250.

Wanted, Immediately, an

experienced FOUNDRY FOREMAN; must have held a similar position previously, be active, sober, and thoroughly able to direct and control about 30 men, including Fettlers, &c. One having a good all-round experience of plate moulding, cylinder work and general jobbing, with experience in piece-work preferred. Give full detailed information of previous situations, experience, age, wages required, whether society or not. No person already employed on Government work will be engaged.—Apply, your nearest LABOUR EXCHANGE, mentioning this Journal and F 173.

Wanted, High-class Mill-

WRIGHT, capable of erecting and working seamless tube making machinery. No person already employed on Government work will be engaged.—Apply, stating age, experience, and wages required, to your nearest LABOUR EXCHANGE, mentioning this Journal and F 216.

Engineering Pupil.—Vacancy

with Firm (Government Contractors) manufacturing latest types of machinery, oil and gas engines, &c.; moderate premium.—Address, 6321, Offices of Engineering.

A Large Firm of Engineers,

in the Midlands, have an OPENING for a YOUTH of good education as premium pupil, the course to include both works and drawing office.—Address, 4339, Offices of Engineering.

SITUATIONS WANTED.

Works Manager or Organiser

OPEN for ENGAGEMENT. Specialist in all details of mass production. Experienced in manufacture of aeronautical engines, special and standard machine tools, jigs and tools, &c.—Address, F 221, Offices of Engineering.

Graduate Engineer (Ineligi-

ble), with over 10 years' experience in telegraphy and telephony, WANTS POSITION, with preference in firm operating or manufacturing wireless apparatus.—Address, F 185, Offices of Engineering.

Production Engineer, with

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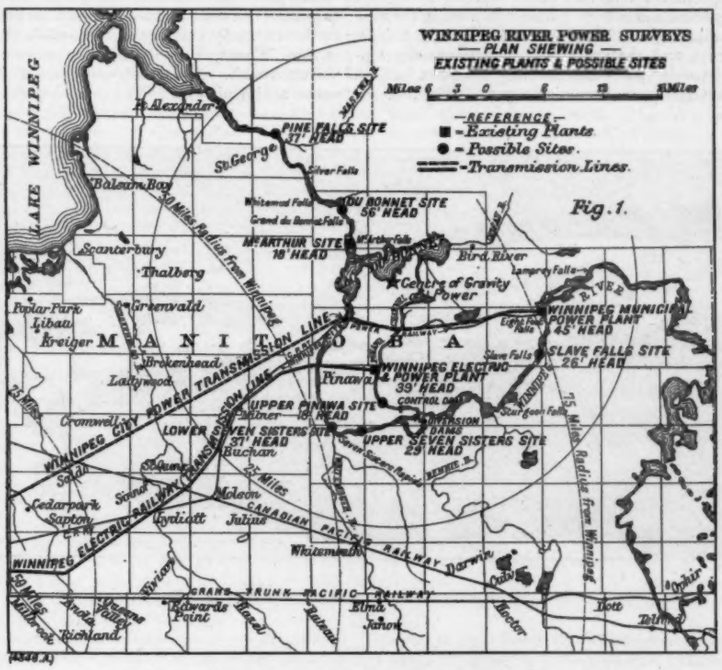
THE HARNESSING OF THE WINNIPEG RIVER.

MANITOBA has exhibited an admirable sense of prevision. Recognising the necessity of deriving the utmost from the sources of energy latent in the many streams and lakes of the province, she has early bestirred herself to take the necessary steps for developing an organised and efficient system by which power can be economically generated and distributed to distant stations where it can be conveniently utilised. Prudently, a systematic and comprehensive survey over a considerable area has been instituted in order to determine the value and the extent of the resources and to ascertain the most appropriate means for rendering these available. Experience in Canada, as in other countries, has shown that the more accessible waters are seized upon by early settlers and speculators who, by acquiring "vested interests" and water rights in a partial and haphazard way, make any subsequent attempt to establish a wide-embracing scheme difficult of attainment. The heavy, and possibly, unremunerative expenditure necessary for the construction of dams and large engineering works is shirked, and some considerable portion of the water power remains unutilised, while the community is robbed of the advantages that a more prudent foresight could have assured.


WINNIPEG RIVER POWER SURVEYS
— PLAN SHEWING —
EXISTING PLANTS & POSSIBLE SITES
Miles 6 3 0 6 12 18 Miles
—REFERENCE—
■ - Existing Plants.
● - Possible Sites.
——— - Transmission Lines.
Fig. 1.
LAKE WINNIPEG
PINE FALLS SITE 37' HEAD
DU BONNET SITE 56' HEAD
McARTHUR SITE 18' HEAD
WINNIPEG MUNICIPAL POWER PLANT 45' HEAD
SLAVE FALLS SITE 26' HEAD
WINNIPEG ELECTRIC POWER PLANT 39' HEAD
UPPER PINAWA SITE 18' HEAD
LOWER SEVEN SISTERS SITE 37' HEAD
UPPER SEVEN SISTERS SITE 29' HEAD
WINNIPEG CITY POWER TRANSMISSION LINE
WINNIPEG ELECTRIC RAILWAY (TRANSMISSION LINE)
CANADIAN PACIFIC RAILWAY
GRAND TRUNK PACIFIC RAILWAY
MANITOBA
St. Alexander
St. George
Balsam Bay
Scanterbury
Thalberg
Grunewald
Poplar Park
Libau
Kreiger
Brokenhead
Lattymood
Cromwell
Sagkeeng
Sagkeeng
Cedarpark
Sapton
Lydiatt
Julius
Moleon
Whitemouth
Darwin
Otaby
Hector
Dott
Telmire
Elmit
Jarvis
Edwards Point
Aylmer
Tyndall
Tricksland
Whitemouth Falls
Grand du Bonnet Falls
Silver Falls
Bird River
Lamprey Falls
Slave Falls
Sturgeon Falls
Centre of Gravity of Power
Pinawa
Laterner
Bachan
Squirrel
Second
Spruce
Wyrton
Aylmer
Aylmer
Aylmer

admitted that local circumstances will need close attention, and that the general question of ice thrust demands the gravest consideration. When the ice breaks up in the spring fresh inconveniences have to be met. The broken-up blocks of ice, with boulders and miscellaneous drift, are floated down stream, with the result that there is a jam, till the increasing pressure overcomes the obstruction and the whole mass is floated down stream to reinforce some previous accumulation, the whole being carried with growing impetus till disaster is threatened. If the jam occurs below the power station, the tail water may be held up and float out the plant. Winnipeg river, in respect to ice-logging, enjoys a favourable position. We have already alluded to the feeble current and the numerous lakes that operate as equalising reservoirs in regulating the flow; both features tend to diminish the evil, and the conservation contemplated will have a still greater steadying effect by creating practically a series of ponds, which will cause the ice to move very slowly, and at the same time promote the equal melting and disposal of the ice-cover.

Frazil ice, that is formed on agitated surfaces by the rapid adherence and accumulation of fine needle-like ice crystals, and anchor ice, formed on the river bed, 30 or 40 ft. below the surface, differ in their origin from sheet ice, but in their destructive effects of hindering operations are tolerably similar. Frazil ice, though, brings a trouble peculiar to itself, since the crystals attach themselves very readily to all heat-conducting surfaces. The iron racks, gates and wheels, wherever metal emerges from the water, are quickly embedded, and from the accumulation of these crystals not infrequently a partial or complete closing off of the water from the turbines results. Forethought in the design can greatly mitigate the inconveniences due to frazil and anchor ice. A quiet and undisturbed current can be assured, and protecting curtains along the face of the racks are also of assistance. To such precautions the existing plant that serves the city of Winnipeg owes its immunity from ice troubles. Fig. 2 gives some idea of the severe conditions likely to be encountered.

The amount of water available for power purposes at all seasons of the year is of prime importance, but in this case statistics depending on precipitation, character of vegetation, climate, &c., are necessarily vague. Details of rainfall and of stream measurement generally must be scanty in a country that has been but partially occupied for a short time. Averages of precipitation and of evaporation are little trustworthy when the number of observations are derived from few stations, spread over a short interval of time. The area concerned is as large as that of England, and we know that we should be led into considerable error if we inferred a uniform rainfall over the whole of the country. The question is further complicated by the wealth of lakes and waterways that intersect the district, and particularly by the part played in the water system by the Lake of the Woods—the great natural regulating reservoir—its numerous outlets, and the extent to which they are used for power purposes. Using the existing data to their fullest extent—and eight years appears to be the limit attainable—the average discharge of the river amounts to 25,375 cub. ft. per second, and the measured deviations from that total betoken a fairly stable climate. A monthly record of 104.3 per cent. above the average is shown, as well as one of 52.1 per cent. below, but the steadiness of the flow in longer periods, as a year, appears to be very satisfactory. The maximum annual measured discharge is 34,000, and the minimum 19,000 sec.-ft. For short intervals the low fall may sink to 11,700 sec.-ft. The high-water marks along the bank indicate that in past times a discharge of 100,000 sec.-ft. must have better represented the maximum flood.

The minimum flood to be expected in any year is the measure of the capacity of the power plant, without storage, and with 12,000 sec.-ft. the utmost that can be accomplished is to concentrate the entire unused river fall in Manitoba into seven economic power installations with a maximum output of 175,000 continuous 24-hour h.p., but if storage can be efficiently carried out and the river regulated to a 20,000 sec.-ft. minimum flow, the output can be raised to 313,000 h.p. Taking into account the plant already established or in course of construction, the total ultimate power available is 420,000 continuous horse-power. Storage, therefore, and the method of effecting it becomes of enormous importance and, in general terms, we have ventured to suggest that the data for solving the problem are insufficient. Mr. Johnston admits that the study is one of some difficulty—we should add, also of some uncertainty. But the question is one entirely for local determination, complicated as it is by a most intricate geography and involved in questions of international significance, for it must be remembered that the United States boundary cuts across the Lake of the Woods, whose commanding position as a reservoir has been recognised by all interested in the water conservation of the district.

The great size of the lake, 1,500 sq. miles in area, and its large contributory watershed, emphasise its importance, but the water utilised for power having at all times been considerably below the run-off available, careful conservation has not been necessary, and the extent of its ultimate development depends upon comparatively unknown factors. New conditions are becoming urgent. The increase of hydro-electric plant on the lower river in Manitoba has already necessitated a pressing demand for auxiliary flow, which under the circumstances could be readily met. In 1914, and again in 1915, a critical situation on the Winnipeg river was relieved by drawing on the lake storage, and in the immediate future such demands will become more frequent, pointing to the need of careful systematisation and gauging. We can conceive that very troublesome questions will arise if the storage is carried to its extreme limit, for great as the supply is, the demand appears to be still greater. A careful and apparently impartial examination of the prevailing conditions shows that in order to maintain the mean discharge uniform through the seven years for which data are extant, provision would have to be made for the storage of 430 billions of cubic feet of water, a quantity that would raise the level of the lake 10 ft. The equivalent of a five-foot storage on the Lake of the Woods is considered feasible, and this would generally permit a continuous outflow of 13,000 sec.-ft., or prevent the minimum falling below 10,500 cub. ft. Under a complete system of storage reservoirs and careful control a 12,000 sec.-ft. flow might be ensured. How far it is safe to count for further supply on Lakes Rainy and Namaquam, large bodies of water in the south of the watershed, wholly or in part within the United States boundary, may be open to question. We accept the conclusions here arrived at with some hesitation, but our ignorance of local conditions will not permit us to question their accuracy. Rainy Lake, 330 sq. miles in area, and draining a watershed of 14,000 sq. miles, may be counted on for 6,000 sec.-ft., but needs a thorough system of storage reservoirs. The English river, with which is connected Lac Seul in the northern part of the watershed, and situated wholly in the Province of Ontario, is credited with another 6,000–7,000 sec.-ft. discharge in practical operation. But it is admitted that the conditions obtaining on the English river are very similar to those on the Winnipeg, and we may anticipate that the water power will be conserved for hydro-electric development along the river as the demand becomes more acute. Finally, the numerous small lakes, of considerable area in the aggregate, can be made to furnish a not unimportant quota, but the construction of many dams would be necessary to make this supply available. Without considering that disadvantage, the existing lumbering, fishing and milling industries would probably object to the full utilisation of the water supply, and even if the plan of creating and maintaining a large number of small and scattered reservoirs is practically feasible, it is doubtful if it would prove economically successful. We have not taken into account further demands for power at the stations already existing at the outlets of the Lake of the Woods, but these have certainly to be reckoned with. The maintenance of a 20,000 sec.-ft. seems a difficult task. The most hopeful auxiliary appears to lie in the waters of Lac Seul, and Mr. Johnston hints that the next considerable storage reservoir to be established in the watershed will attack the virgin waters of that source.

(To be continued.)

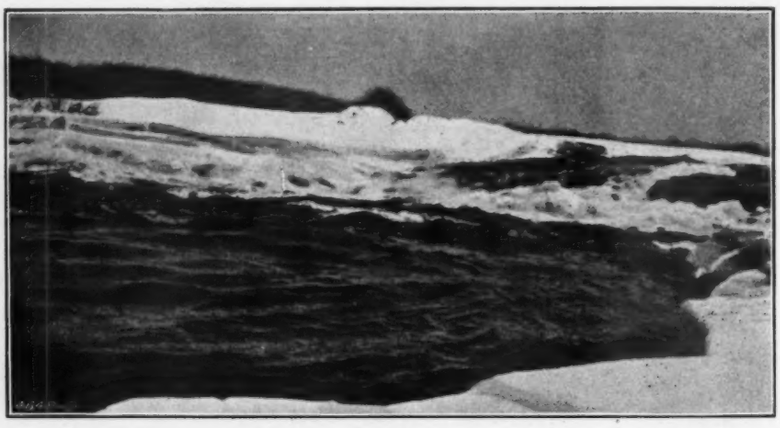


Fig. 2. Ice Conditions below Du Bonnet Falls.

The Carbo-Teredo Timber Process.—By the courtesy of Mr. E. Trench, M.Inst.C.E., the Engineer of the London and North-Western Railways, Mr. J. E. Cunningham, of Sydney, demonstrated, on the 29th ult., his Carbo-Teredo process at the divisional engineer's yard, Watford Junction, in the presence of engineers representing nearly all the main line railways. The inventor exhibited sections from treated and untreated hardwood and Oregon pine timbers employed in five tests conducted by the Board of Reference of the New South Wales Department of Public Works and the Commissioners of the Sydney Harbour Trust. He also produced a photograph showing the result of a white ant test laid down by the engineers of the Commonwealth Postal Department. In view of the exceptional fierceness of the attack both by teredo and termites, the evidence of exclusion appeared to be convincing. Broadly speaking, the process consists of impregnation with a hydro-carbon followed by burning with a high-pressure gas flame. It is applied to piles before and after they are slung to the frame of the driver, so that there is assurance that the protecting stratum is intact when it passes into the water. Though the process was primarily directed against the operations of borers, it has been ascertained that it protects timber from weathering and decay. It has been suggested that the treatment may not avail when applied to railway sleepers because the exterior surface is likely to be abraded by movement under vibration against ballast. Mr. Cunningham, however, claims that the necessary protection is maintained by the calcined undercrust, which, in fact, is a hardening of the surface of soft wood. In order to elucidate this point he has treated a Baltic sleeper, which Mr. Trench proposes to submit to a prolonged test. We understand that the process is being used by several Australian Governments for wharfs, railway and road bridges, and river embankments.

THE BRITISH ASSOCIATION.

(*Continued from page* 321.)

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Gravity at Sea. Comparison of Aneroid and Mercury Barometers.

Last year Professor W. G. Duffield, D.Sc., of Reading University College, presented an interim report of the Committee on the "Determination of Gravity at Sea," of which he is secretary, this report describing the work he had done on the journey to and from Australia, under great difficulties, on board the Ascanius, which Messrs. Alfred Holt and Co. had specially fitted with a constant pressure chamber for this purpose, and afterwards on the Morea, into which the apparatus had to be transferred when the Ascanius was requisitioned by the Government.* In this year's report he dealt with the "Comparison of the Aneroid and Mercury Barometers" he had used—one of the three methods applied—fully discussing the many difficulties and sources of error, and giving the results of the very laborious computation of his observations. The main result—an apparent deficiency of gravity over the deep Indian Ocean—was, he said, almost startling, being contrary to the isostatic theory of the distribution of the materials in the earth's crust. Even if it should not be confirmed the whole investigation and the experience gained will be most important for the necessary future work.

In 1866, Dr. Duffield pointed out, Wüllerstorf-Urbair had suggested making use of an aneroid in conjunction with a mercury barometer for gravity measurements. Aneroids had been much improved since, and Dr. Duffield had taken advantage of the offer of such an instrument by the Cambridge Scientific Instrument Company, designed by Mr. Horace Darwin. Future work would have to decide whether the fall in the value of gravity over the deep sea between Australia and India was real, or was due to some systematic error to which the aneroid was found liable, or to some other cause. At present it looked as if Helmert's formula did not hold good, gravity being appreciably less over the deep ocean than over land areas, whilst over land areas the normal value might be exceeded. The principle of the method was that the pressures recorded by the aneroid and by the mercury should be equal; this latter was $h \rho g$, where h was the height and ρ the density of the mercury; ρ and h depended upon the temperature, so that a constant temperature was needed.

The mercury marine barometer was provided with a constriction of the bore in order to reduce excessive pumping of the mercury on board ship. This pumping and lag had been studied by Stokes, Hecker and Chree, and Dr. Duffield doubted that any formula-correction could really meet it; rolling and pitching, the throbbing of the engine, all had their effect (the former possibly asymmetrical, otherwise useful, as it shook the barometer). The capacity measurements and readings were difficult on board, and Dr. Duffield had, therefore, recently suggested (in the Royal Society) a new type of barometer without constriction. The temperature correction was the most serious, as an error of 0.1 deg. C. would involve an uncertainty in gravity of 0.02 cm. per second per second.

The aneroid used, he continued, showed a variation with time, the readings rising in the course of time, contrary to other aneroids. The pumping was of a peculiar nature. On his suggestion the aneroid had been mounted on a horizontal axis. Thirteen aneroids were so connected in series by short rods that they resembled wheels on a horizontal axis, which would expand or contract with the combined pressure variations. This axis was suspended from a beam by two springs and mounted between the pointed end of a screw (with milled head) on the one side and a stop on the other; measurements were made by turning the screw until the other end of the axis made vibrating contact with the stop. The cradle was placed in a box, and the box was suspended by three spiral springs from three bars intersecting in the common point of support. Though the axis was parallel to the keel of the ship, pumping was observed even when the ship rolled, not only when it pitched. The latitude, the throbbing of the engine, the horizontal motion of the ship (setting up centrifugal force, according to Eötvös, difficult to allow for with tidal currents), even the immersion of the ship (loading) would influence the readings. In order to convince himself whether the systematic error caused by the pumping of the aneroid could be responsible for the low gravity values observed, Dr. Duffield plotted the deviations from the formula against the maximum differences from the mean of each set of readings; but there was no definite result; moderate pumping went together with too high as well as with too low gravity values. Measurements with the aid of a reflected light spot might have been preferable. The temperature fluctuations caused particular trouble; they were small (within 1 deg. C. mostly) on the Ascanius, but large on the Morea (6 and 7 deg. C.).

Under these circumstances Dr. Duffield offered his results with all reserve. Yet the parallelism between his gravity curves and the sea-depth soundings is quite surprising, and, if confirmed, the result would be a heavy blow to the isostatic theory of the earth's equilibrium. The curves exhibited started from Fremantle, in West Australia, where the ocean descends to a depth of 6,000 m.; gravity decreased on parallel lines, being 0.2 or 0.3 cm. per second squared less than Pratt's hypothesis demanded. As India was approached, gravity went up, and the curves crossed, soon to run parallel again; there would be a possible influence of the Western Ghats mountains on this route. Peculiar oscillations observed near Colombo, due to the mountains of Ceylon, perhaps, were entirely confirmed by observations made by a different method. The Red Sea is shallow throughout; there was a very small deficiency of gravity in the centre of the Sea, more pronounced near Suez, and, strangely enough, also in the Suez Canal. In the Mediterranean there was an increase in gravity as the bed of the sea rises. There is no question as to the competency and conscientiousness of Dr. Duffield.

The report was discussed by Professor H. H. Turner and Colonel Hills; in reply to the latter Dr. Duffield stated that he had adopted the aneroid and not tried the boiling-point method because he had agreed with Dr. Hecker—with whom he worked at Strassburg before starting—that the six months' time he had at his disposal would not enable him to master the technique of that method.*

Energy in Spectral Lines.

Dr. R. T. Beatty, of Queen's University, Belfast, gave a first account of his experiments on "Measurement of the Energy in Spectral Lines."† The energy of the radiations emitted by gases in vacuum tubes was exceedingly small, he pointed out. Attempts at measurement had been made with the aid of thermopiles (recently perfected by Joly) and by photometric methods (Nutting). He had tried photo-electric cells. His cell was a glass bulb partly lined inside with metal (alkali, better silver); this metal was charged to a potential of, say, 150 volts; the other electrode was a wire (terminating in the bulb opposite a window) joined to an electrometer whose charge was balanced by a high-resistance (glycerine and copper sulphate) potentiometer. His comparison source of light was the grey-body radiation from a carbon filament. The light from a vacuum tube was reflected from a prism and entered the window of the cell through a slit. Exciting hydrogen at about 1 mm. pressure by alternating currents, he found very little energy in the blue line, more in the green, and much more energy in the red line, whilst in ordinary experiments with photo-electric cells the energy decreased in the order green, blue, red. In the hydrogen experiments, moreover, the energy of the red lines increased much more than that of the other lines when the current was increased, and when oxygen or chlorine were added to the hydrogen gas, so that water or hydrochloric acid might be formed; the hydrogen lines in question belonged to the same series. Experiments with other gases had also been made, but an enormous amount of work remained to be done.

Commenting upon this communication, Professor W. M. Hicks remarked that exact measurements of the energy were very desirable. What Dr. Beatty had obtained seemed to be not the intensity of the vibrations of the atom (which was probably constant), but an indication of the number of atoms or particles taking part in the oscillations. An increase in the current might increase the number of atoms emitting red light more apparently than the number of atoms emitting blue radiation, and a further increase might decompose the atoms into configurations giving other lines. In reply to Sir E. Rutherford, Dr. Beatty stated that his (very regular) curves indicated actually observed (not corrected) energies.

Osmotic Pressure.

The discussion on "Osmotic Pressure" was opened by Professor A. W. Porter, F.R.S., of University College, London, who almost at once dived right down to the root of the problem. When a bladder containing sugar or salt solution was immersed in pure water, he said, the water forced its way into the bladder and extended it, whilst it did not allow the sugar to diffuse out in the opposite direction. When the membranes were perfect—and those used by the recent experimenters, the Earl of Berkeley and his collaborators in England, and Mr. H. N. Morse in Baltimore, were almost perfect—this one-sided diffusion went on until the excess of the pressure in the solution over that of the pure water amounted to the full osmotic pressure. When the membranes were imperfect, diffusion occurred in both directions, ultimately resulting in uniform pressure distribution on both sides. Professor Porter did not touch on these cases of so-called "anomalous osmotic pressure" at all, but discussed the theory. Empirically the osmotic pressure could be calculated by Avogadro's law, as though the dissolved substance were a gas and the solvent were absent. Almost every property of a solution, he remarked, had been called in aid for explanation. But the only theory from which the osmotic pressure could be calculated was that of Van 't Hoff, according to whom Avogadro's law was followed because in a dilute solution the dissolved substance behaved like gaseous molecules moving about in the solvent medium. But that explanation had met with strong opposition from physicists and certain chemists, and the recent controversy between Ehrenfest and Van Laar had made it clear that the gas theory of this pressure was not understood by scientists like Van Laar even now, as he spoke of the liquid flow being in the wrong direction. Professor Porter subsequently dissociated himself emphatically from the criticism which the late G. F. Fitzgerald had applied to the dynamic osmotic pressure theory in his Helmholtz Memorial Lecture (Chemical Society, 1896), "one of the most noteworthy contributions to the cult of caution in scientific theories," in Professor Porter's opinion. It was at the Leeds meeting of 1890, we might add, that Orbwald and Van 't Hoff personally attempted to explain the new dissociation theory (which found strong support in the high osmotic pressures of electrolytes) to unsympathetic British Association members.

Professor Porter pointed out that if all the complications of the kinetic theory of gases had been urged from the first, that theory—which was not complete even now—would never have had any success. There was no adequate equation of state yet for any gas consisting of one type of molecule

* See Engineering, vol. c, page 346.

* It is somewhat curious that in the discussion above referred to no mention was made of the experiments carried out over 40 years ago by the late Sir C. William Siemens. As long ago as 1859 Siemens proposed a method of obtaining ocean soundings by measuring the diminution of the force of gravity when traversing such masses of water. Difficulties in the way of constructing satisfactory instruments, however, led to the matter being dropped, but it was taken up again in 1875 when work in connection with the laying of submarine cables gave rise to the want of a method of making a rapid survey of ocean depths. In the year named Sir William Siemens brought out the "bathometer," an instrument which we illustrated and described on page 260 of vol. xxi of Engineering, and which formed the subject of a paper contributed by Sir William to the *Philosophical Transactions* in 1876. Some very successful tests of the instrument took place on board the Faraday, the instrumental readings being compared with direct soundings. For instance, in a trial made on October 31, 1875, in positions where direct soundings gave depths of 82, 204 and 69 fathoms, the bathometer readings were 82, 218 and 78 fathoms.

† We held our notice of this paper over last week, in the hope of being able to give diagrams.

only; could they expect fully to explain the osmotic pressure problems for cases comprising molecules of solvent and of solute? They had to be satisfied if they could deal with idealised cases. There was actually osmotic pressure in a really *gaseous* mixture. Hot silica was permeable to helium. Immerse a silica vessel containing hydrogen at pressure p into helium at pressure p_0. The helium passed inside the vessel until the helium pressure was the same inside and outside; the total pressure inside was $p + p_0$, outside p_0; the difference was p, which was equal to the gas pressure of the contained hydrogen. That difference had arisen from the diffusion of helium, which was due, not to any attracting forces, but to the molecular motion of the helium. If the walls of the vessel were extensible, its volume would increase unless an opposite external pressure were applied. It was not, as Van Laar said, that the bombarding hydrogen molecules kept the helium out; they extended the vessel, and thus made the entry of the helium possible. Attraction between molecules, surface tension, &c., did not concern this ideal case at all.

When a membrane separated pure water from a solution in water of some substance, these factors and the volume of the solute molecules could also be neglected in the first instance. That particles suspended in a fluid were in rapid Brownian motion like the molecules of a gas might have been doubted till a few years ago, but could no longer be doubted now. Owing to this motion there was an outwardly directed force, greater than when that motion was absent by an amount given by the gas laws; this force tended to enlarge the vessel containing the solution. Unless an external pressure equal to p were applied, the water would flow into the solution; the *causa causans* was not this flow, but the motion of the solute molecules. It was preferable, however, to consider the two events as concomitant and not as cause and effect. For dilute solutions this theory and experiment were indeed in accord. In the case of concentrated solutions the forces between the solute molecules and between them and the solvent could no longer be neglected, and indeed became the more important factor. That consideration, however, only introduced complications of the same kind as in gases. It did not mean that the gas theory had to be given up, not any more than Van der Waals gave up that theory when introducing his a and b into the formula $pv = RT$. Most of the objections to the gas theory of osmotic pressure rested on the fact that the laws of Boyle and Charles were not really satisfied by any single gas, and the solutions dealt with were mixtures of liquids. Calculated on the simple $p = RT/v$ analogy, Berkeley's osmotic pressure values observed (and calculated) were still in fair agreement for solutions containing 176.8 grammes of cane sugar per litre, the values being then 14.2 (12.0), but not at all for solutions containing 659.6 and 751.4 grammes, the pressure values being 100.1 (46) and 134.8 (52.5). While Berkeley had especially studied a wide range of concentration, Morse had particularly investigated the temperature relations over the range 0 to 80 deg. C. Morse calculated his concentrations in grammes per 1,000 grammes of pure solvent, and a good deal of confusion had arisen because various experimenters expressed their concentrations and results in different ways. There were, however, discrepancies between the results of different observers, and even between Berkeley and Morse, for the same solutions of small concentrations, and as long as these discrepancies persisted the experimental side was not quite satisfactory. Professor Porter proceeded to analyse Morse's values with regard to association of water molecules with one another and with the solute (hydration), as to which he differed from Professor Callendar with regard to heat of dilution (with which he dealt in the Faraday Society a few years ago and on which Mr. D. Orson Wood was, he said, now again experimenting at University College) and to solubility and its change with temperature, finally referring also to the depression of freezing-point and of the vapour pressure and to the rise of boiling-point consequent upon adding a solute to a liquid. This analysis was mathematical and does not admit of abstracting.

The discussion was continued by Dr. Frank Tinker, of the University of Birmingham. The common membranes, Dr. Tinker pointed out, were aggregations of closely-packed colloid particles, and the pores were really the interstices between the particles. The colloidal particles of copper ferrocyanide* had several hundred times the diameter of the water molecules, the pores had 10 or 100 times that diameter and were themselves several times larger than the sugar molecules. Several facts had to be considered: (1) The colloidal membranes adsorbed both the solvent and the solute, on their surfaces and into their pores; the adsorption was selective, however, and different proportions of the two were taken up. When a copper ferrocyanide membrane was immersed in sugar solution, water was alone adsorbed, this being an extreme case of negative adsorption. The membrane enclosing the barley seed took up water only from solutions of salt, sugar and glycerol, but it absorbed phenol, aniline and acetic acid in several times the strength of the solutions (paper by Professor Adrian Brown and Dr. Tinker now before the Royal Society). Other cases of positive and of negative adsorptions could be given. (2) The amount of solvent taken up by the membrane depended upon the concentration of the solution in contact with the membrane, and decreased when the concentration increased. Thus, 100 grammes of pure dry copper ferrocyanide (colloidal) took up 30 grammes of water from pure water, but only 13 grammes of water from cane sugar solution of 60 per cent. Hence a membrane in sugar solution would contain more moisture on the pure water side than on the solution side, and thus diffusion of the water into the solution took place. That view of Graham's had been taken up again by Professor Trouton (presidential address to Section A, Melbourne, 1914), and it contained the correct explanation, so far as it went. (3) The amount of solvent and solute adsorbed also depended upon the external pressure, and increased as the pressure increased. If the hydrostatic pressure were equal to the osmotic pressure the colloid would take up as much moisture from the solution as from the pure solvent, according to Trouton, and the diffusion-flow would then stop for this reason.

Dr. Tinker then passed to a consideration of the phenomena on kinetic grounds, whilst others preferred thermo-dynamic arguments. In that consideration attention had to be focused on the solvent rather than on the solute (as was usually done), because it was the solvent which flowed. What the solute did was that it separated the solvent molecules from one another, and consequently reduced the fluid pressure of the solvent inside the solution below its value inside the pure solvent. Thus osmotic flow resolved itself into an expansion of the solvent from a region of high fluid pressure to one of low fluid pressure. Application of pressure to the solution compressed the latter, and increased the fluid pressure of the solvent within the solution, tending to stop the osmotic flow. At osmotic equilibrium there was equality of pressures (liquid and vapour pressures) in similar phases throughout the system. This could be proved by kinetics alone with the aid of Dieterici's equation of state. Dr. Tinker had just shown in the *Philosophical Magazine* how this equation could be applied to the determination of the vapour pressures of binary liquid mixtures, and had shown also that the equation led to the same general equation for these mixtures as Van Laar had obtained with the aid of the thermo-dynamic potential.

Professor W. C. McC. Lewis, of Liverpool University, rising next, said that it was difficult to ascribe the osmotic pressure to molecular gas bombardment in the case of a non-volatile solute, such as sugar, and difficult to visualise how the surface layer prevented volatilisation if the solute really acted as a gas. Capillary and electro-capillary effects and preferential adsorption of solute or solvent no doubt played an important part, though they hardly offered a complete explanation of the phenomena. He (the speaker) would lay more stress upon the fact of solvation. On the solution side of the membrane there were some molecules of the solvent bound to the solute, and there were therefore fewer *free* solvent molecules on that side than on the other; hence more solvent passed over into the solution. If N_0 and N_1 indicated the numbers of these molecules per unit volume, the osmotic pressure was proportional to $N_0 - N_1$, and should therefore be proportional to the concentration (if small). For concentrated solutions a relation $p(v - b) =$ constant (at constant temperature), where b was the volume of the hydrated solute molecules, should and did hold according to Sackur. But one did not see why the gas constant should come in, and there was not sufficient experimental evidence so far to come to a definite conclusion.

Lord Berkeley, being unable to attend, had sent Professor Porter a note on the results of unpublished vapour pressure determinations made by himself and Mr. E. G. J. Hartley. They passed air over the solution and then over the pure solvent, the relative losses in weight giving a measure of the vapour pressures; combining these results with the compressibility of the solutions, they calculated the osmotic pressure by Porter's equation. We summarise their table, giving in A concentration (number of grammes of anhydrous solute per 1,000 grammes of water), in B the osmotic pressure observed, and in C the values calculated as stated, for

Cane sugar	A : 81.262 to 141.107 B : 67.74 to 134.84 C : 67.48 to 134.97
Methyl glucoside ...	A : 34.767 to 75.709 B : 47.72 to 117.19 C : 47.92 to 116.82
Calcium ferrocyanide	A : 31.389 to 49.897 B : 41.22 to 131.00 C : 41.10 to 131.33

The agreement was excellent throughout. They had assumed that $RT = 22.3909$, finding that the R they calculated from the constants of water vapour at 30 deg. C. agreed very closely with the R of Landolt and Börnstein for nitrogen.

Professor Porter, replying, stated that the idea taken up by Dr. Tinker, that the action of the membrane was a consequence of the differences of solubility with concentration, was very plausible; it had also been held by Nernst, but been given up ultimately, because there were complications due to the gradient of pressure in the membrane. Professor Lewis, he thought, was neglecting the field of force due to the variation of the Laplacean pressure near the free surface of the solution; molecules of solute, which were moving freely in the body of the solution, might be brought to rest before they reached the free surface, and in such cases the solute was non-volatile. Further, if the osmotic pressure were to be due to differences of concentration of solvent on the two sides of the membrane, then there should be no osmotic pressure in his (Porter's) ideal case, in which the volume of the solute molecule was zero. A similar statement made in respect to gases would make gas pressure entirely dependent upon the molecular volumes, whereas it was known that this volume only caused deviations from the perfect gas laws for such pressures.

Mathematical Papers.

We can only mention the papers discussed in the department of mathematics: Professor G. N. Watson, of Trinity College, Cambridge, on "Oscillating and Asymptotic Series"; Professor R. W. Genese, of Aberystwith, on "Suggestions for the Practical Treatment of the Standard Cubic Equation and a Contribution to the Substitution Theory"; and Dr. H. R. Hassé, "Note on a Problem of Boltzmann's and its Relation to Radiation."

SECTION B.—CHEMISTRY.

The compact, instructive programme drawn up by the organising committee of Section B, essentially a discussion of two vital actual problems, fully justified itself. The first question concerned the Present Position and Future Prospects of the British Chemical Industry. That was the subject of the presidential address and of the four papers, two at least of equal general interest, which were read after the delivery of the address. An exhibition of British-made chemicals and apparatus was open in the same building during the meeting. The second subject was Coal, in the first instance Fuel Economy,

* The artificial membranes of the physicist are mostly not the natural membranes of the biologist, but clay cells, impregnated (after Traube) first with copper sulphate, and then with potassium ferrocyanide, so that a precipitate of copper ferrocyanide is formed within the pores of the cell walls.

Utilisation of Coal and Smoke Prevention, to which Section B and G devoted a whole day, as we have already reported. In the second instance, the Chemical and Geological Characters of Coal and the most effective Utilisation of Coal; the chemists and geologists discussed this problem together in a joint meeting, on one morning. The remaining time was occupied by the presentation of a few more isolated papers and committee reports. The Section met in one of the lecture halls of the College of Medicine, under the presidency of Professor G. G. Henderson, D.Sc., F.R.S., of the West of Scotland Technical College, Glasgow. Professor A. W. Bone, F.R.S., Dr. J. T. Dunn, of Newcastle, and Dr. J. E. Stead, F.R.S., acted as vice-presidents; Dr. A. Holt, of the Muspratt Laboratory of Physical Chemistry, Liverpool University, was the recorder; and Drs. C. H. Desch, R. Robinson, of Liverpool, and J. A. Smyth, of Newcastle, were the secretaries.

Present Position and Future Prospects of the British Chemical Industry.

Professor Henderson dwelt in the first words of his address on the sorrows of the war. Having then briefly reviewed the progress made in every branch of pure and applied chemistry—he subsequently characterised the boundaries between the domains of pure and of applied chemistry as merely "traditional"—since the Association last met in Newcastle in 1889, he turned to his main subject, going back to his introductory remarks.

It was, he stated, perhaps no exaggeration to say that nothing less than such an upheaval of existing habits and traditions as had been created by the war would have sufficed to arouse the British nation from the state of apathy towards science with which it had been fatuously contented in the past. "But," he said, "I believe that a brighter day is dawning, and that if only we rise to the occasion *now*, chemistry in this country will attain the position of importance which is its due. Meantime it is of no avail to lament lost opportunities or to indulge in unprofitable recrimination; on the contrary, it should be our business to find a remedy for the 'arrested development' of our chemical industry, and the task of establishing remedial measures should be taken in hand by the State, the universities and the chemical manufacturers themselves." The Government had taken a most significant step in advance by appointing an Advisory Council for Scientific and Industrial Research and providing it with funds. A sub-committee of the Advisory Committee to the Board of Trade on Commercial Intelligence had made recommendations in order to secure the position of certain branches of British industry after the war. Of these, Professor Henderson quoted: (1) Scientific industrial research and training (larger funds to be placed at the disposal of the Privy Council Committee; the universities to be encouraged to extend research work in co-operation with the manufacturers; trade associations to seek the guidance of the Privy Council Committee as to non-localised industries; an authoritative record of consultant scientists, chemists, engineers and others to be established by the Government, for the use of manufacturers only). (2) Tariff protection in cases where the national supply of articles of vital importance to the national safety or essential to other industries had fallen into the hands of manufacturers or traders outside this country. (3) Patents—to secure uniformity of patent laws throughout the Empire and to enforce compulsory working of patents in the United Kingdom.

Professor Henderson welcomed these weighty recommendations, and further drew attention to the steps taken by the Prime Minister of Australia. A Committee had been appointed for establishing a Commonwealth Institute of Science and Industry, to ascertain which industrial problems were most pressing, to build up a bureau of scientific and industrial information, and to erect and control research laboratories. This admirable scheme could, he said, be rivalled without difficulty, since the United Kingdom possessed its Advisory Council and National Physical Laboratory, to which a National Chemical Laboratory should be added. The suggestion made by Dr. M. O. Forster of a Chemical Intelligence Department of the Board of Trade* had also much to recommend it; the principal objection, that the department would soon be gagged by red tape, could be obviated by the institution of a strong advisory committee representative of and elected by the societies concerned with the different branches of chemistry, which would keep closely in touch with the Commercial Intelligence Department on the one hand, and with the industry on the other, and which would act as adviser of the permanent scientific staff of the department. The president said that he feared there was little chance of seeing the proposal carried into effect unless all the societies concerned moved actively and unitedly in the matter. They must do the pioneer work and must submit a definite scheme to the Government, if the desired result was to be attained. In the not improbable contingency of the Board of Trade declining to take action he trusted that the scheme for the establishment of an information bureau, on lines similar to, but somewhat less wide-reaching than the above, which had been under the careful consideration of the Council of the Society of Chemical Industry, would be vigorously prosecuted. But it was essential that the representatives of the industry should organise themselves to fight the common enemy, and more than ever necessary considering that the three groups of German producers of dyes, drugs and fine chemicals had formed a combination with a capital of more than 11,000,000*l*. It was eminently satisfactory, therefore, to record the active progress of a movement, originated by the Chemical Society, which had culminated in the formation of an association of British Chemical Manufacturers; that movement had the full support of a conjoint board of scientific societies. The main objects of the association were to promote co-operation between British chemical manufacturers; to act as a medium for placing before the Government and Government officials the views of manufacturers upon matters affecting the chemical industry; to develop technical organisation and promote industrial research; to keep in touch with the progress of chemical knowledge and to facilitate the development of new British industries and the extension of existing ones; and to encourage the sympathetic association of British manufacturers with the various universities and technical colleges. Every one interested in the welfare of our chemical industry could assist the movement.

Chemical manufacturers, Professor Henderson continued, could also help themselves in the way he had pointed out in his address to the Society of Chemical Industry last year. In the United States manufacturers, individual and associated, had instituted industrial research scholarships (a scheme of the late Professor Duncan) tenable at universities or colleges, and 10 years' experience had amply justified the scheme, which provided definite problems of technical research for qualified chemists. On the other hand, the foundation of the Willard-Gibbs chair of research in pure chemistry at the Pittsburg University was most significant. Mr. A. P. Fleming, who had recently visited the research laboratories of the United States, had found that more than 50 corporations maintained research laboratories at a cost of from 20,000*l*. to 100,000*l*. annually, some planned in the most lavish manner for large-scale operations; men who had proven their capacity in places like the Mellon Institute and the Bureau of Standards were absorbed by the industries.

It could not be reiterated too often, Professor Henderson proceeded, that no branch of industry could afford to stand still; for there was no finality in manufacturing processes, all were capable of improvement. For this and for new discoveries trained chemists were required, and the opportunities for chemical instruction were immensely greater than they had been 30 years ago. Even the ancient universities recognised the claims of chemistry. The evening classes in technical institutions were hardly fitted to produce fully trained chemists, if only for lack of time; but they played a most important part, and in a large number of schools a more or less satisfactory introduction to the science was being given. With our national habit of self-depreciation we were apt to overlook the steady progress made. There was, of course, room for improvement. It was unfortunate that so many students left universities with a science degree, but without any experience in investigation. It was perhaps too much to ask that practice in research should be made an indispensable qualification for the ordinary degree. Failing this, promising students should be encouraged to continue their studies by the award of research scholarships. The output of research work from the Scottish universities had very greatly increased since the scheme of the Carnegie Trust for the institution of such scholarships had come into operation. No amount of training would make a man an investigator unless he had the natural gift, of course; but a large army of men trained in methods of research was needed to carry out the ideas of the master mind. Skilled analysts were likewise indispensable, though much of the routine work was advisedly left to apprentices controlled by the chemist. Lastly, there should be a demand for the chemist of commercial faculty for the buying and selling of materials. A course of chemical engineering, such as was now given in the University of Glasgow, which had recently introduced a degree in Applied Chemistry, was a necessity for any industrial chemist. On the whole there was not much fault to be found now with the training that universities and technical colleges offered to the chemist. The difficulty was the *personnel*. The junior members of the staff were miserably underpaid; it would be regarded as insanity to suggest that even an eminent scientist should enjoy more than a fraction of the salary of a music-hall artiste or a lawyer-politician. But the Government grants should be increased, and wealthy men over here might take an example from America, where the private donations for science and education of the last 43 years amounted to 117,000,000*l*. and the annual average now to nearly 6,000,000*l*. Over here education was unfortunately still administered on classical lines, administrative officials and legislators had little acquaintance with scientific facts and principles, and science was still treated with indifference and rarely with intelligent appreciation by statesmen and members of the public services. But there, again, the prospects were brighter than before, because the warnings and appeals of men of science had at last, and after many years, begun to bear fruit, or rather, the lessons of the war had begun to make an impression on the powers that be. It had been intimated that a committee was to be appointed to inquire into the position of science in our national system of education, especially in universities and secondary schools. This committee will advise the authorities how to promote the advancement of pure science, and also the interests of trades, industries and the professions dependent on science, bearing in mind the needs of what is described as a liberal education. The committee was to include scientific men. Those who appreciated the application of science to commerce and industry, and some able to correlate scientific teaching with education as a whole. It was to be hoped, for the sake of the country, that their recommendations would be adopted and put in force with the least possible delay.

In proposing the vote of thanks to the president, Dr. J. E. Stead said that he would bear Professor Henderson's valuable suggestions in mind with regard to their technical college at Middlesbrough. Professor A. W. Bone, who seconded the vote, deprecated their relying too much on State assistance; he also hoped that chemical industry would never rely upon fiscal protection; he was, and remained, a strong free-trader.

(To be continued.)

* See Engineering, February 4, 1916, page 108.

HIGH-POWERED LOCOMOTIVES FOR THE PENNSYLVANIA RAILROAD.

(Continued from page 296.)

In the general views of the two classes of locomotive which we have been describing, given in Figs. 1 and 5, on pages 98 and 99 *ante*, both classes are shown provided with the same type of tender, this being known as the 7,000-gallon tender. This pattern of tender is the standard for the "K 4 S" and "E 6 S" classes of engine, and some of the "L 1 S" class were originally provided with it; but practically all "L 1 S" engines are now fitted with 9,000-gallon tenders, and the remaining engines of the class will soon be similarly equipped. The

DETAILS OF 9,000-GALLON TENDER; PENNSYLVANIA RAILROAD.

MR. J. T. WALLIS, GENERAL SUPERINTENDENT OF MOTIVE POWER.

Fig. 198.

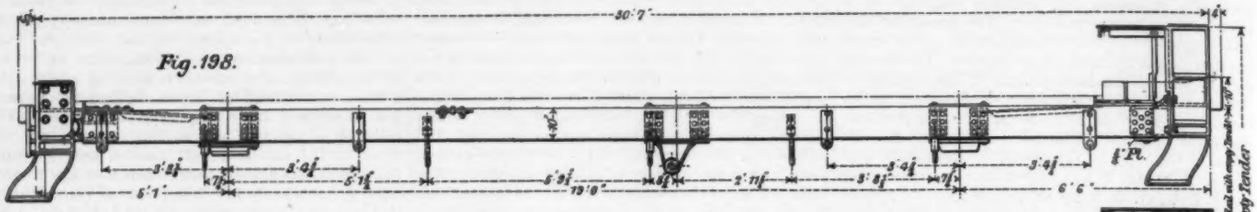


Fig. 199.

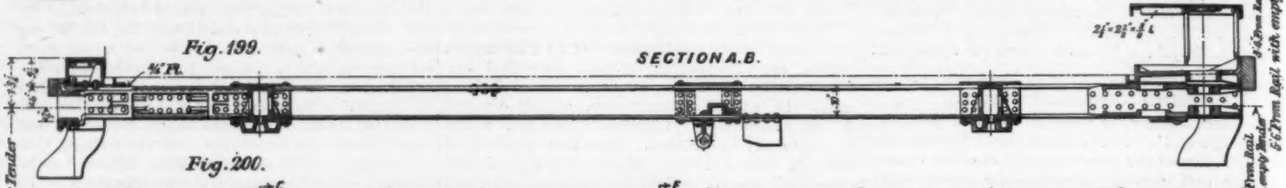


Fig. 200.

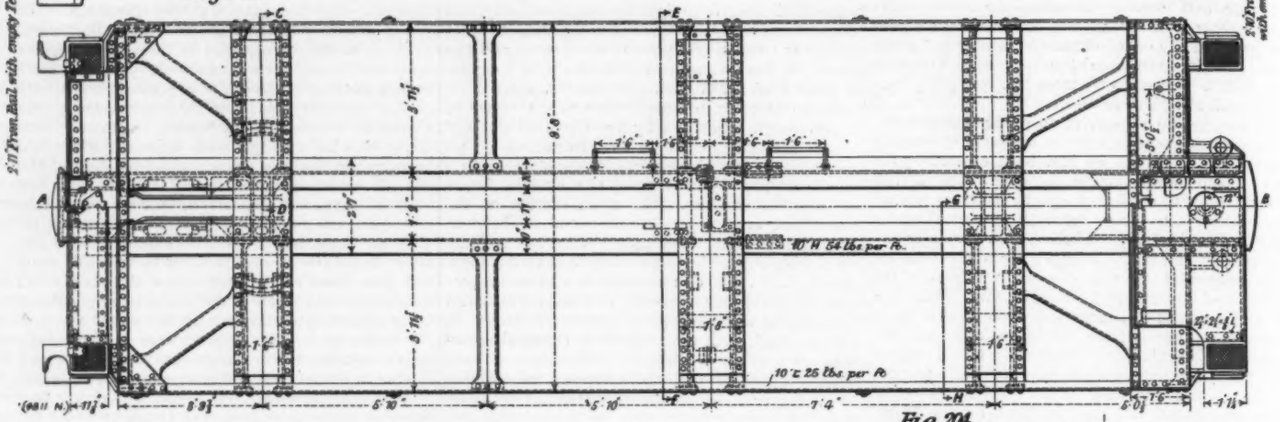


Fig. 201.

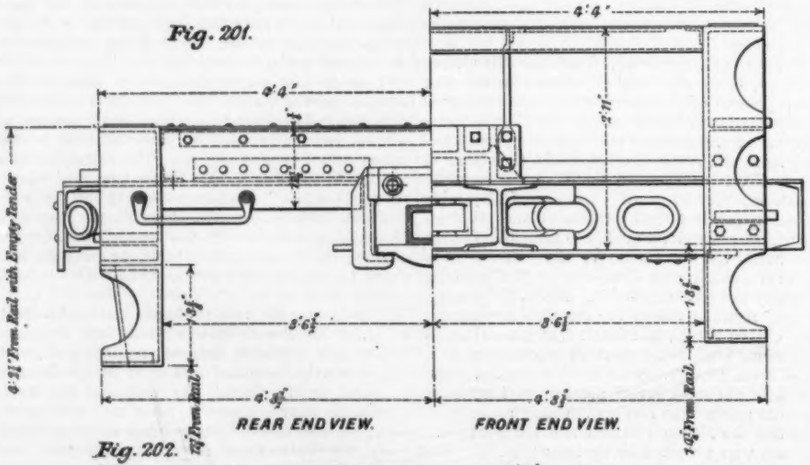


Fig. 202.

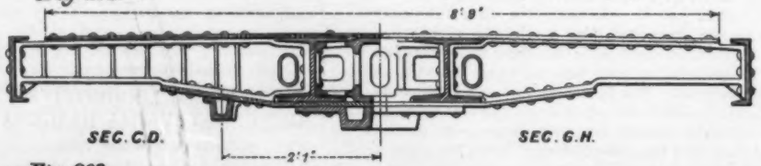


Fig. 203.

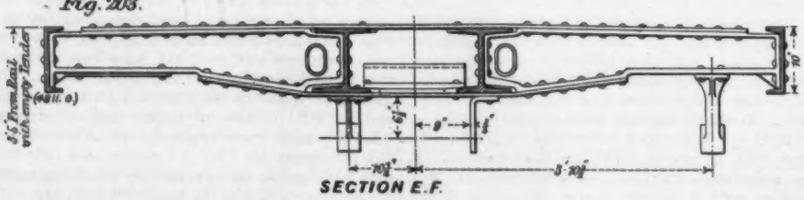


Fig. 204.

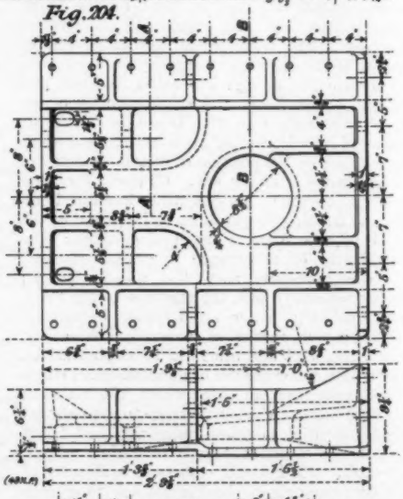


Fig. 205.

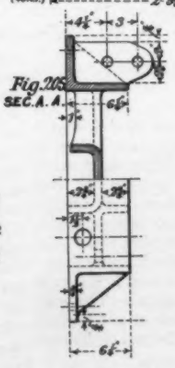
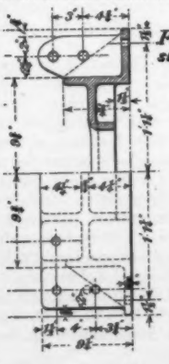
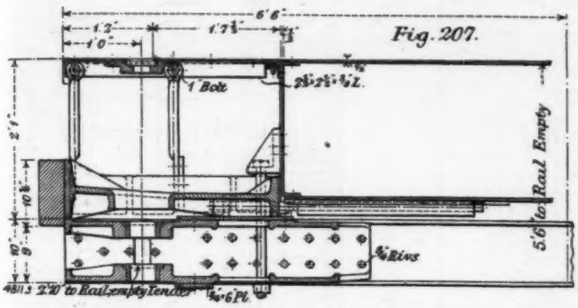


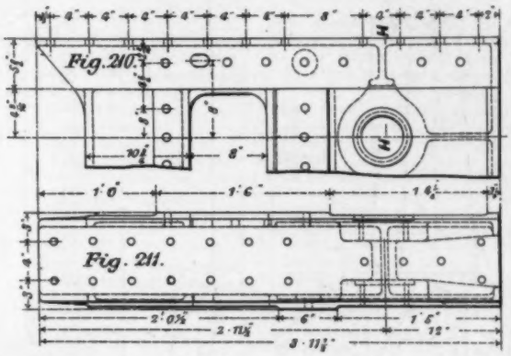
Fig. 206.

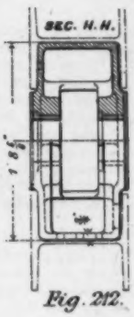


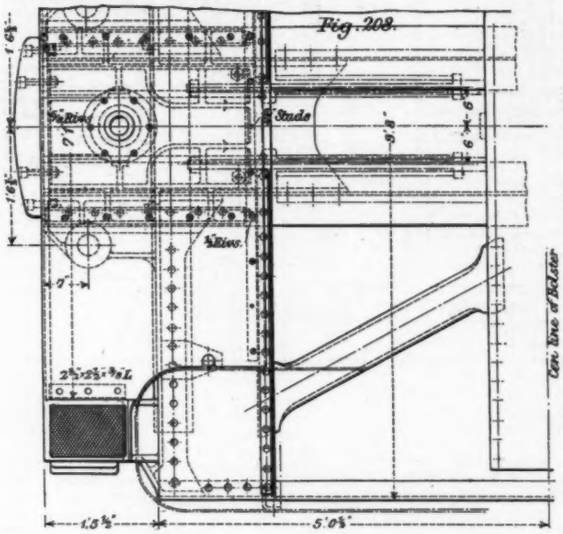
DETAILS OF 9,000-GALLON TENDER; PENNSYLVANIA RAILROAD.

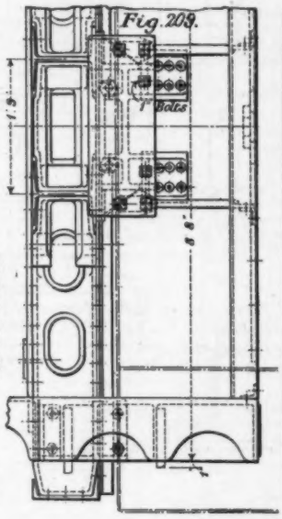
MR. J. T. WALLIS, GENERAL SUPERINTENDENT OF MOTIVE POWER.

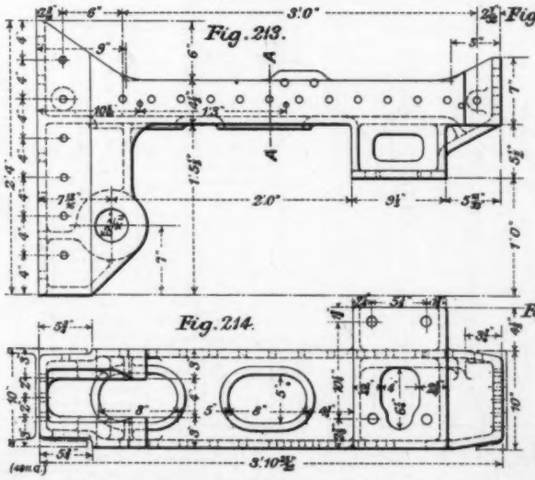


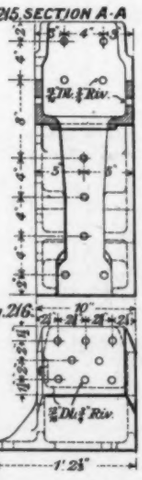


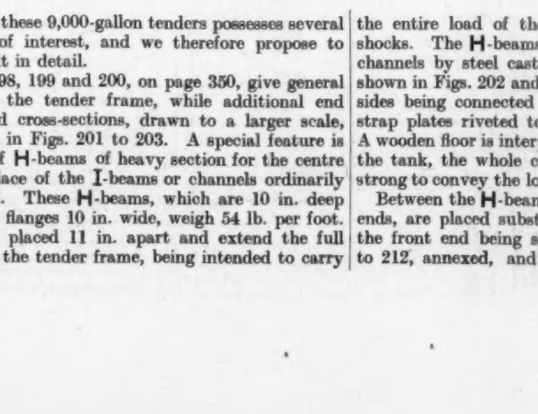


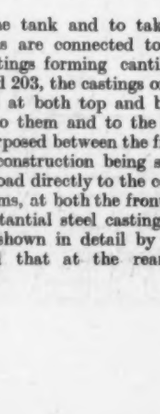












design of these 9,000-gallon tenders possesses several features of interest, and we therefore propose to describe it in detail.

Figs. 198, 199 and 200, on page 350, give general views of the tender frame, while additional end views and cross-sections, drawn to a larger scale, are given in Figs. 201 to 203. A special feature is the use of H-beams of heavy section for the centre sills in place of the I-beams or channels ordinarily employed. These H-beams, which are 10 in. deep and have flanges 10 in. wide, weigh 54 lb. per foot. They are placed 11 in. apart and extend the full length of the tender frame, being intended to carry the entire load of the tank and to take all end shocks. The H-beams are connected to the side channels by steel castings forming cantilevers, as shown in Figs. 202 and 203, the castings on opposite sides being connected at both top and bottom by strap plates riveted to them and to the H-beams. A wooden floor is interposed between the frames and the tank, the whole construction being sufficiently strong to convey the load directly to the centre sills.

Between the H-beams, at both the front and rear ends, are placed substantial steel castings, that at the front end being shown in detail by Figs. 201 to 212, annexed, and that at the rear end by Figs. 224 to 228, on page 352. Other castings at the front end are shown by Figs. 204 to 206, on page 350, and by Figs. 213 to 216, annexed. Of these, the casting shown in plan in Fig. 204 is situated immediately below that shown in Fig. 210, while a pair of the castings shown in plan in Fig. 213 form the connections at the front end between the central sills and the side channel irons. Together, this group of castings forms a complete front end connection, including draw-bar and safety-bar attachments, tank stop, and step castings support. The whole assembly at the front end is shown clearly by Figs. 207 to 209, on the present page.

The assembly at the rear end is shown generally by the plan, Fig. 200, on page 350, and in greater detail by Figs. 217 to 220 and Figs. 229 to 232, on page 352, while, as already mentioned, Figs. 224 to 228 show the steel casting situated between the central sills at that end. This last-named casting forms a combination draught casting and frame filler at the rear bolster and encloses the Westinghouse draught cylinders and the draught rigging, as shown in Figs. 230 and 231.

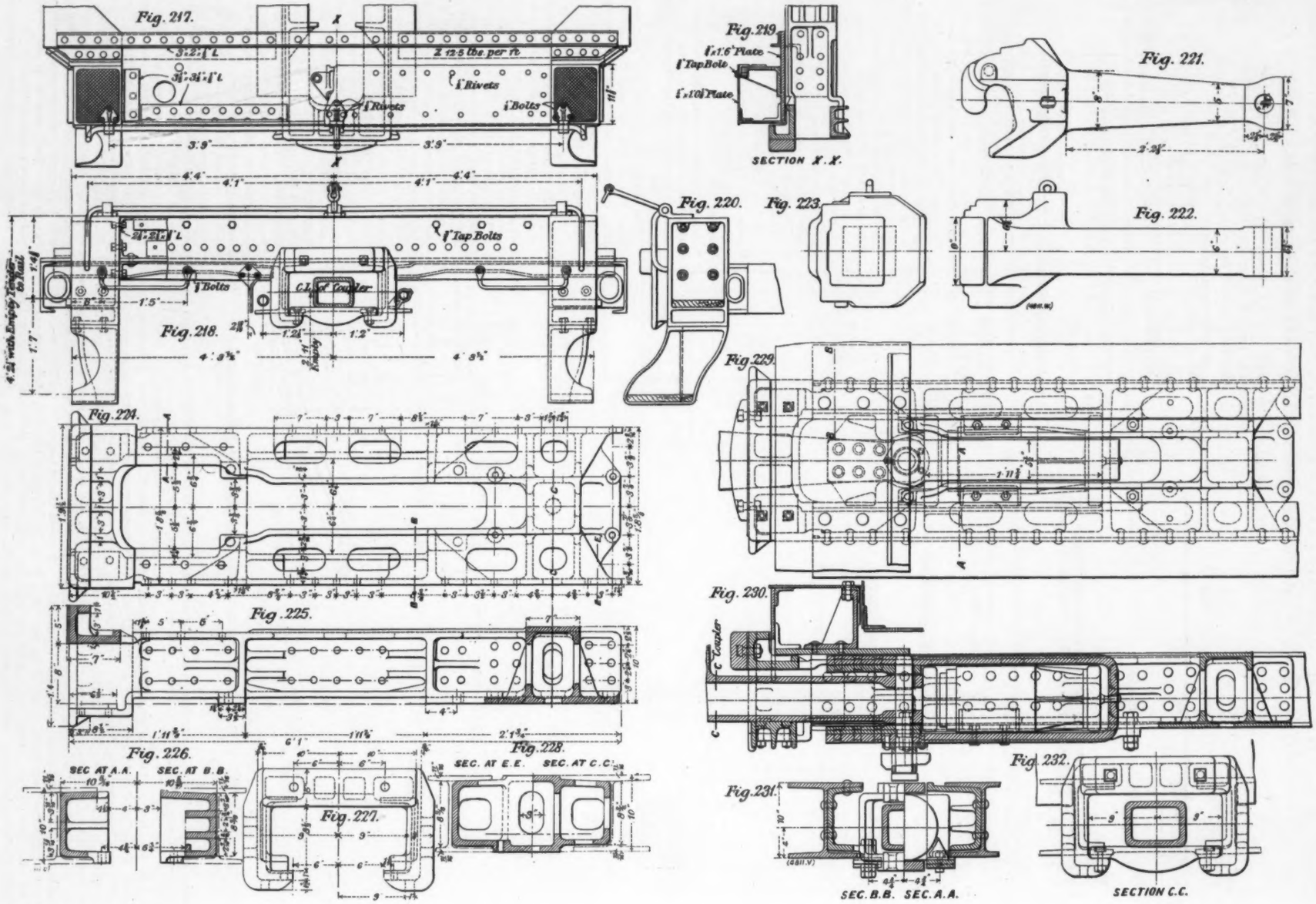
The details of the draught rigging illustrated in Figs. 229 to 232, on page 352, show a departure from the usual practice of the Pennsylvania Railroad. On reference to these views it will be seen that the draught yoke has riveted to its rear end a yoke casting, the form of which is best seen in Fig. 229, where it is shown in dotted lines. This casting is designed so as to allow ample side play for the coupler and at the same time has ample strength. The coupler itself is shown separately in Figs. 221 to 223. This arrangement of draught yoke has been developed to overcome breakages of the lugs in the older form of draught yokes, which were necessarily loaded eccentrically and which gave considerable trouble. The new arrangement illustrated has been found perfectly satisfactory.

The tender under notice is mounted on two four-wheeled trucks. A number of different designs of tender trucks have been used on the Pennsylvania Railroad, the older practice being to apply to tenders in freight service arch-bar trucks with elliptical springs, and to tenders in passenger service pedestal type trucks. Some difficulty was experienced with the arch-bar trucks due to failures of the arch-bars themselves, while the pedestal type trucks were found to be more difficult to maintain. It was also found that the pedestal type truck was not flexible enough to accommodate itself to all conditions of service, so that the want of a better truck was felt. To satisfy these conditions a truck was designed—known as the "Dolphin" truck—which is illustrated in Figs. 233 to 238, on page 354. In this truck it will be noticed the loads are taken by elliptical springs and helical springs placed in series between the centre plate and the axle boxes, the centre plate and bolster being provided with special hangers to allow lateral motion to the extent of 3 in. on each side of the centre line. The design of the truck was made especially strong, it being intended to employ it in high-speed passenger service. The constructive details are clearly shown in our illustrations, and will not need special description.

To determine the relative vibration in equipment

DETAILS OF 9,000-GALLON TENDER; PENNSYLVANIA RAILROAD.

MR. J. T. WALLIS, GENERAL SUPERINTENDENT OF MOTIVE POWER.



having tender trucks of different types in connection with different types of trailer trucks on the engine a series of seismograph readings were taken in 1913. These formed the subject of an interesting and valuable report, with which we hope to deal on a future occasion. Meanwhile we may state that it was found that the use of the type of truck just described resulted in making both tender and engine ride much more easily. In the illustrations on page 354, Figs. 233, 234, 235 and 237 show clearly the arrangement of the brake gear on this type of truck.

(To be continued.)

INDUSTRIAL NOTES.

A PAPER (Memorandum No. 13) dealing with juvenile employment at munition works has recently been issued by the Ministry of Munitions. It states that in the past the need for the welfare supervision of boys has not been so widely recognised as in the case of women and girls; present conditions have, however, served to call attention to its urgency, and it is receiving the attention of an increasing number of employers. Boys fresh from the discipline of a well-ordered school need help and friendly supervision in the unfamiliar turmoil of their new surroundings. They are not men and cannot be treated as such. On the other hand, high wages and the absence of the father have frequently tended to relax home control. Healthy and organised recreation is seldom available. As might be anticipated under these circumstances, complaint is often made of boys leaving their work after a few days or playing truant; this may be the result of slackness and discontent, or the cause may be found in fatigue, sickness, or perhaps home troubles. If smooth working is to be secured, the real causes of such discontent and trouble must be ascertained and appreciated. Experience, however, shows that the problems involved are outside and distinct from those of ordinary factory discipline, and they are likely to remain unsolved unless someone is specially deputed for the purpose.

The solution of these problems, adds the paper from which we quote, has been taken in hand by the Welfare Department of the Ministry, who have issued special memoranda dealing with the duty of a welfare supervisor. The more important of these may be briefly summarised as:—(*a*) To become acquainted with all boys when first employed, to be present at the medical examination by the factory surgeon, to note any matters needing attention, to arrange for the re-examination of special cases. (*b*) To visit cases of sickness and to investigate other causes of irregular attendance and of complaints in regard to work. (*c*) To receive complaints made by boys and their parents, and to dispose of misunderstandings. (*d*) To be consulted before any boy is dismissed. (*e*) To watch the conditions of housing and transit and the facilities for obtaining food. (*f*) To supervise and promote arrangements for saving. (*g*) To seek facilities for recreation and to organise their use.

In a circular issued last Friday by the Ministry of Munitions it is stated that the continued demand for labour for the construction of munition factories and other buildings of urgent national importance, coupled with the enormous demand for steel for the purposes of the war, have compelled the Ministry of Munitions, in the national interest, to place certain restrictions upon private building. The public would be well advised, adds the circular, to take advantage of the period during which the regulation is in force to get plans prepared for future undertakings, so that work may be ready to start when the demobilisation of the army begins after the war. If this can be prepared for beforehand, it will be of great advantage when the problems of demobilisation become urgent.

An agreement has now been concluded by representatives of the Admiralty, the Ministry of Munitions and the Board of Trade with the Liverpool Shipwrights' Trade and Friendly Association and the Liverpool District Committee of the Ship Constructors' and Shipwrights' Association. It deals with the organisation of labour in the shipbuilding and ship-repairing trades in the Mersey. The clauses, 14 in number, provide, among other points, that there shall be interchangeability between shipwrights and drillers and hole-cutters; there shall also be transfer of members from one establishment to another. In all cases where the work is of such a character or the conditions such as to enable the labour introduced to perform the work with reasonable efficiency, skilled men from allied and other trades, and semi-skilled and unskilled labour, and women—when the work is appropriate and the conditions and surroundings are suitable to their sex—may be introduced. All rules and customs which tend to restrict output are suspended for the period of the war. All differences arising out of or in connection with the agreement shall, without stoppage of work, be referred to and settled by Mr. Lynden Macassey, K.C.

According to the *Newcastle Daily Chronicle* it was officially announced last Friday by the general secretaries to the Board of Conciliation and Arbitration for the North of England Manufactured Iron and Steel Trade, after having received the ascertainment of the average net selling price of steel plates at Consett during the months of June, July and August, that in accordance with the agreement entered into on March 30, 1896, the wages to be paid to the steel millmen in the current quarter beginning October 1 would be at the increased rate of 7½ per cent., or, in other words, 55 per cent. above the standard.

The Consett men were conceded their first advance of 10 per cent. under the existing scale three months ago. For a year prior to the war the wages were on the downward grade, and had declined to 12½ per cent. above the standard when hostilities broke out. There was no change in the following December quarter; but there was a 2½ per cent. advance in April, 1915, succeeded by 7½ in July; and in the three subsequent quarters the increase was 5 per cent. As already mentioned, there was a jump of 10 per cent. in July last; and the present 7½ per cent. is only the second time the wages have similarly increased. Never in the history of the Consett Works have the wages attained 55 per cent. above the basis, the previous highest rate being 27½ per cent. beyond the standard in December, 1900.

At a meeting of the Cleveland ironstone mineowners and of the miners' representatives, held last Monday at Middlesbrough, Sir Hugh Bell occupying the chair, it was decided after discussion that the miners' wages should be advanced by 10½ per cent. from Monday, the 23rd inst.

The Board of Trade announce that in future the Labour Exchanges under their control will be termed "Employment Exchanges," a title which corresponds more accurately to their present functions.

The scope of the Employment Department of the Board of Trade will be enlarged so as to include in addition to Employment Exchanges and Unemployment Insurance, Trade Boards and certain other matters relating to labour. Mr. W. H. Beveridge, C.B., will continue to be the head of the enlarged Employment Department.

The President has appointed Mr. C. F. Rey (hitherto General Manager of Labour Exchanges) to be Director of Employment Exchanges in succession to Mr. Beveridge, with the acting rank of an Assistant Secretary.

According to statistics collected by the German Imperial Statistical Bureau there were in Germany in the year 1882, 7,340,789 persons employed in the various industries, of whom 1,509,167 were women, that is, about 20.6 per cent. Since then the percentage of female labour has been steadily increasing, and in parts of Germany, in which connection Silesia is generally specially mentioned, women are regularly employed in some of the hardest work, which elsewhere is looked upon as unsuited to females. The percentage of female labour has risen very materially during the war in Germany, as in the other belligerent countries, and it will remain high after the conclusion of peace; but no very complete details are yet available in this connection. The reports of the sick funds, however, throw an interesting light upon the increase of female labour. The hands insured in the sick fund institutions were: In 1914, 6,160,912 men and 3,506,164 women; in 1915, 5,254,170 men and 3,839,671 women; and in 1916, 5,288,922 men and 4,793,472 women. The difference in the percentage between male and female employees is gradually diminishing, the figures being as follow: 1914, men 63.7 per cent., women 36.3 per cent.; 1915, men 57.8 per cent., women 42.2 per cent.; 1916, men 52.5 per cent., women 47.5 per cent. Whilst male labour is getting more and more scarce, female labour is offering at an increased rate, and the supply may be taken, in many cases, to be close upon double the demand. The textile and the paper trades, as might be expected, are first in the list of the trades in which female labour exceeds male labour.

Since the year 1902 Swedish employers, as far as their relations to labour are concerned, have had three separate organisations: the Swedish Manufacturing Engineers' Union, the Central Employers' Union and the Swedish Employers' Union, comprising a number of large factories. Almost ever since these bodies were formed the opinion has prevailed that the position of Swedish employers might be further consolidated by a combination of the three unions into one body. It may now be taken for granted that the first of the above three unions, from January 1, 1917, will join the Swedish Employers' Union.

The general belief that the demands of railway trainmen throughout the United States for an eight-hour day means cutting down wages to meet the shorter hours is erroneous, says *The Marine Journal*, New York. On the contrary, the eight-hour day granted means that the railways will be obliged to pay their employees the present ten-hour pay for about 20 per cent. less work than they have heretofore performed. In other words, under the legislation rushed through Congress in the week ended September 2, the trainmen's wages have been raised from 40 to 50 cents an hour, or 25 per cent.

In this connection we may state that according to the *Railway Review*, Chicago, President Ripley, of the Atchison, Topeka & Santa Fé Railway, has issued a formal statement in which he declares that his railway does not intend to comply with the Adamson eight-hour law until he is ordered to so by the United States Supreme Court. His contention is that the law is nothing more than an advance of 20 to 25 per cent. in wages to the men who receive the most money in the railway service. Should the Courts finally decide that the increase must be paid, there will be an immediate demand from the remaining classes of labour, resulting in entire inability to pay without heavy increases in rates charged to the public, especially the farming class. President Ripley asks whether the public is prepared to meet the demand.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, September 27.

LARGE orders for mill products are now beginning to be placed for delivery during the third quarter next year. The trend of prices is therefore upward. It is quite apparent that the maximum output of mills, even with the enormous incoming capacity, is virtually sold up for all of next year. The condition is aggravated by the past hesitancy of domestic consumers to buy sufficiently for forward requirements because of ill-founded impressions as to the termination of the war. The realisation of this error is leading to spasmodic efforts to secure supplies in the face of advancing prices and increasing uncertainties as to remote deliveries. As before indicated vast sums of money are being expended on enlargements. Inquiries are now pending for 20,000 additional cars—one-fourth for Russia, 5,000 for France, and some thousands for Italy. European Governments desire to place orders for 150,000 tons of steel, but negotiations are dragging. Mill interests do not urgently desire to load up at present with business for delivery 9 to 15 months hence. Shipbuilding facilities continue to expand at a surprising rate. At present 397 vessels with an aggregate tonnage of 1,293,000 tons are under contract. The pressure for all kinds of material exceeds capacity. The plan of Russia to build 5,000 miles of railroad a year for four years will help to tax rail-making capacity.

THE LATE MR. WALTER H. WEBB.—We regret to have to announce the death of Mr. Walter H. Webb, managing director of the Liverpool Refrigeration Company, Limited, which occurred on Thursday, the 5th inst., at his residence, No. 2, Boundary-road, Bidston. Mr. Webb was born in 1850, a member of an old Shropshire county family. He took up the profession of engineering and sailed for some years as chief engineer on the steamers of the Red Star Line. He was the first chief engineer of the ss. City of New York. He retired from the sea in 1888 and took up mechanical refrigeration. He was associated with the late Mr. Joseph Knight Kilbourn in the erection of the first ice-making plants of a commercial character in the United Kingdom. He has made many improvements in mechanical refrigeration, particularly in connection with the transport of chilled beef from North and South America. Mr. Webb took no prominent part either in municipal or Imperial affairs. He was a member of the Institution of Naval Architects, a member of the Institute of Marine Engineers, and also a member of the Shropshire Society in London.

"THE COMING CRASH OF PEACE AND BRITAIN'S MECHANICAL RENAISSANCE."—Under this title there has been published, at 2*s.* net, by Messrs. Simpkin, Marshall, Hamilton, Kent and Co., Limited, 4, Stationers' Hall Court, London, E.C., a small brochure of 150 pages, another of the many books published with the object of stirring public opinion to a fuller realisation of the need for organised effort to place our trade on a sounder basis for meeting the trade war which is inevitable upon the conclusion of peace. The author is Mr. T. C. Elder, who has been one of the active agents in the development of the British Electrical and Allied Manufacturers' Association, and the major part of the book is a reproduction of addresses given by him under the auspices of this Association in various English cities. Mr. Elder wields a facile pen, and enforces his arguments with cogency and conviction. He is a strong advocate for Government stimulus under a ministry of commerce. The departments of this ministry, he suggests, should be divided under six definite heads, dealing with finance, transport, works organisation (which would, of course, take up the question of productive and sales efficiency), research and invention, labour, and fresh developments. In working out the broad lines of such Government effort, he deals specially with the engineering industry.

TENDER TRUCK ("DOLPHIN" TYPE); PENNSYLVANIA RAILROAD.

MR. J. T. WALLIS, GENERAL SUPERINTENDENT OF MOTIVE POWER.

(For Description, see Page 349.)

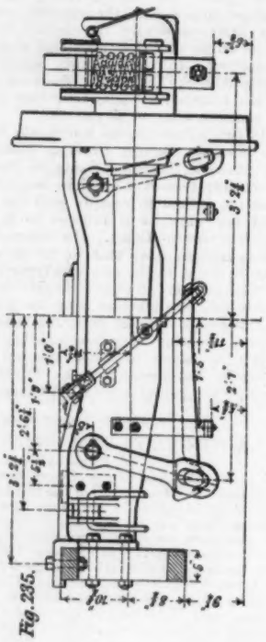


Fig. 235.

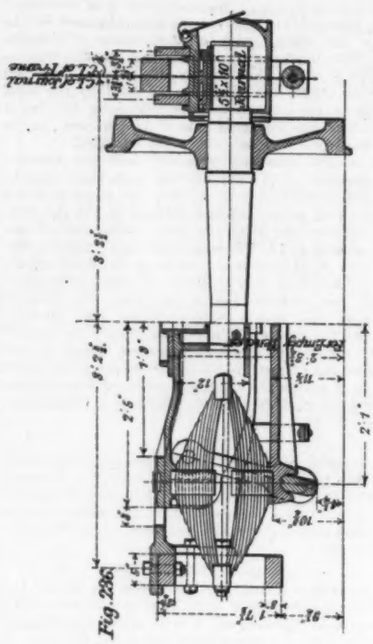


Fig. 236.

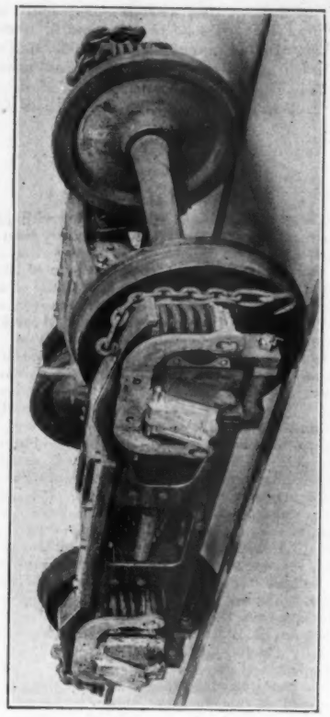


Fig. 238.

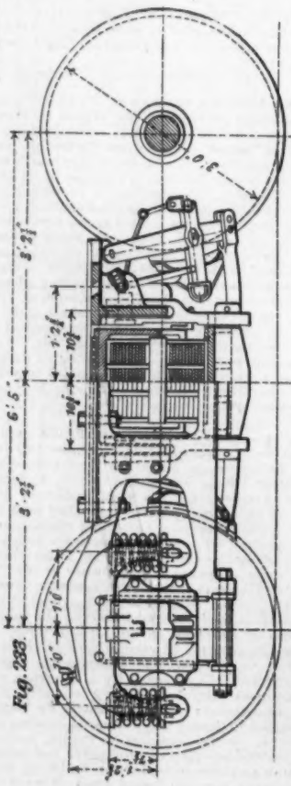


Fig. 233.

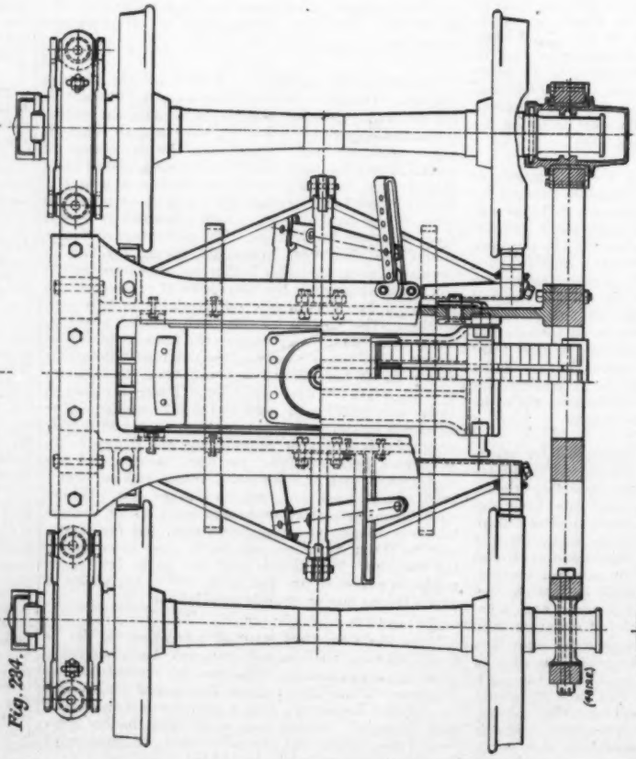


Fig. 234.

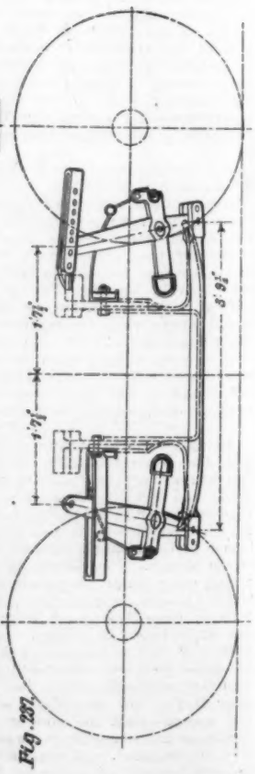


Fig. 237.

THE CARONTE VIADUCT.

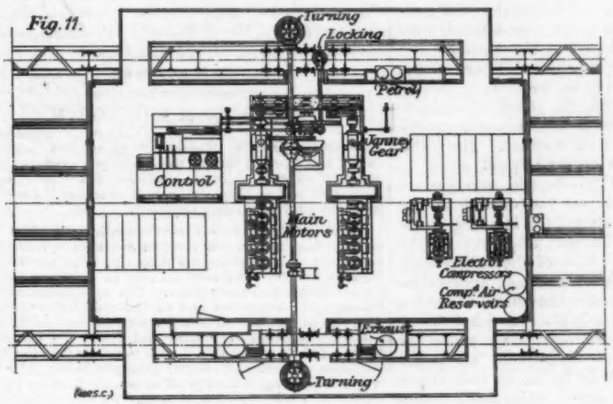
WHEN describing in a former issue the new Rhone-Marseilles Canal* we stated that the construction of this new canal coincided with the opening of a new railway line from Miramas to L'Estaque, to relieve the main line from Paris to Lyons and Marseilles. The new line is shown in the map we published with the article referred to. It runs from Miramas to L'Estaque, *via* Port de Bouc and Martigues, and it may constitute a serious competitor of the new canal. The construction of this new railway line was surrounded with many difficulties. For a great part of its length it runs parallel with the sea coast, being laid on a cutting on the hillside, where the local conditions allowed but little room for the work of construction; moreover, it crosses the Etang de Caronte over a long viaduct which had to contain a swing bridge to allow of communication between the sea and the Etang de Berre. One great advantage of the new line is that it will maintain communication by rail between Marseilles, Lyons and Paris should an accident occur in the Nerthe tunnel, in which runs the older main line. A small line had been in service for many years between Miramas and Port de Bouc, but this was of local interest only, and there was a hiatus between Port de Bouc and Martigues, whence another small local line ran to the entrance of the Nerthe tunnel.

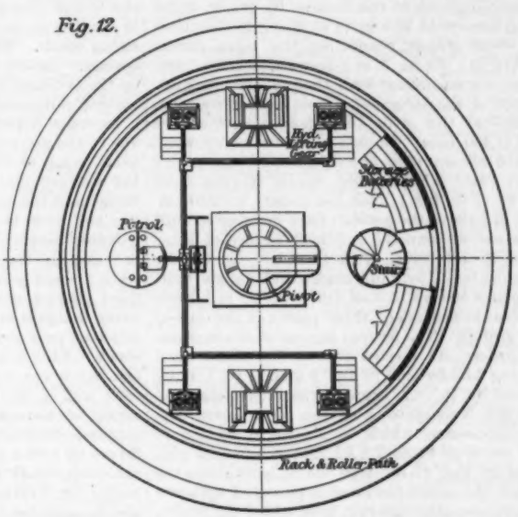
The new railway from Miramas to L'Estaque is built with double track. Its developed length is only about 61 km. (38 miles); of this length about 27 km. (16.8 miles) is on curves, the radius of which does not fall below 500 m. (1,640 ft.) except where the railway leaves Miramas station. Complications arose on the section between L'Estaque and Port de Bouc, where the railway follows the sea coast. On this section there are three steel bridges, having spans of from 30 to 82.5 m. (98 ft. to 270 ft. 8 in.), 18 masonry viaducts, having spans of from 8 to 50 m. (26 to 164 ft.), and a number of tunnels, varying in length from 23 to 652 m. (75 to 2,139 ft.). The most interesting masonry structure is the one called the Eaux Saleés viaduct, which consists of a 50 m. (164 ft.) main semicircular arch, with ten 4.90 m. (16 ft.) semicircular arches, on a gradient of 3 mm. per metre (1 in 333). The key of the main arch is 29 m. (95 ft.) above the ravine. The excavations for one of the abutments had to be driven down to a depth of 45 m. (147 ft.). Over a distance of 14 km. (8.75 miles) it was necessary to provide as many as 22 tunnels of various lengths which, it is true, were comparatively easy to build, except in the case of one, the Carry tunnel, near the point where the line crosses over the canal, and where intricate shoring-up had to be resorted to owing to the nature of the ground cut through. The track throughout is laid with steel flange rails weighing 48 kg. per metre (96 lb. per yard).

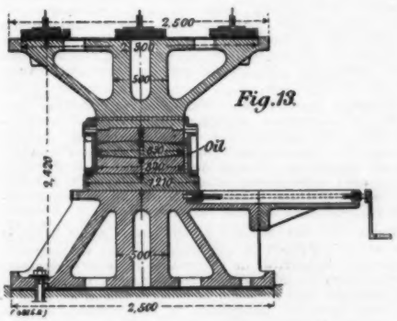
The swing bridge above alluded to, and which we illustrate in Figs. 1 to 10 on Plate XXXI, Figs. 11 to 16 on the present page, and Figs. 17 and 18 on page 358, forms part of a viaduct, styled the Caronte viaduct; the latter has a total length of 943 m. (3,093 ft.). The free height between the water level and the underneath of the swing bridge girders is 23 m. (75 ft. 5 in.) which enables the ordinary ships and fishing smacks to pass freely. The two 51.20 m. (168 ft.) spans at the Miramas end, leading to the swing bridge, together with the latter, were built by Messrs. Schneider, at their Chalons-sur-Saône civil engineering works; whilst Messrs. Daydé et Pillé built the remainder of the viaduct, *i.e.*, the eight 82.50 m. (270 ft. 8 in.) spans. The viaduct carries a double track and the rail level is 24.50 m. (80 ft. 4 in.) above the water level.

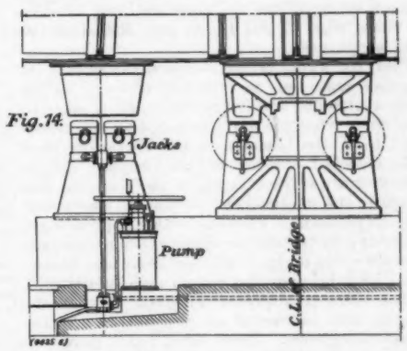
The swing bridge, as shown in Figs. 1 and 2, Plate XXXI, has a total length of 114 m. (374 ft.), and consists of two balanced cantilever arms, each 57 m. (187 ft.) in length and 56.50 m. (185 ft.) in span. The two main girders are 114 m. in total length; they are 9.270 m. (30 ft. 5 in.) apart from centre to centre, and are trapezoidal in shape, their height outside the angles varying from 13.7 m. (45 ft. 11 in.) over the centre pier to 7.6 m. (25 ft.) at the abutment ends.

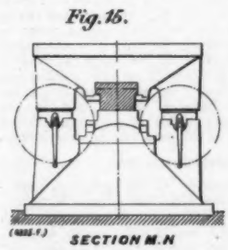
Each of the two main girders consists of four members assembled in pairs and between which are fitted the uprights and diagonals. The upper and lower booms are built up of two channel members, each formed of two 120 by 120 by 15 mm. (4.7 by 4.7 by 0.6 in.) angle bars, with a web plate 16 mm. ($\frac{5}{8}$ in.) in thickness, which is strengthened in the panels close to the centre pier by a second web plate, having a thickness of 10 and of 16 mm. ($\frac{3}{8}$ and $\frac{5}{8}$ in.). The internal distance between the web plates varies from 0.652 to 0.684 m. (25.6 to 26.9 in.). The upper members have a uniform height of 0.600 m. (23$\frac{5}{8}$ in.); the lower ones have that same height over a length of 43.244 m. (141 ft. 10 in.) from each end; in the central part and over 26.512 m. (87 ft.) they are trapezoidal in shape, and the height varies from 0.600 to 1.45 m. (23$\frac{5}{8}$ to 57 in.). This arrangement had for its object to allow at the lower part of the girders above the centre pier the necessary height to assemble in satisfactory conditions the three members of the bracing. The members of the upper and lower booms are braced horizontally by 80 by 40 by 9 mm. (3.14 by 1.57 by 0.354 in.) angles riveted to the upper and lower horizontal sides of the 120 by 120

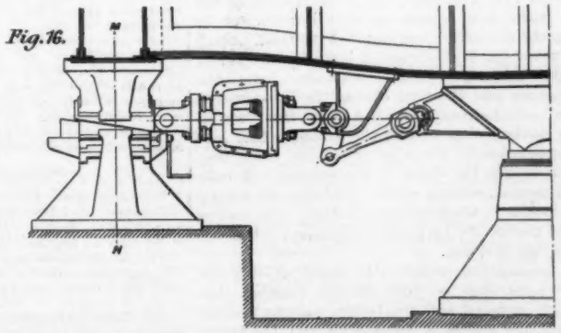












* See ENGINEERING, vol. ci, page 316.

by 15 mm. angles above referred to. At the centre of the length the upper and lower booms of each main girder are connected by a vertical strut or girder, 3.913 m. (12 ft. 10 in.) wide at the top and 6.822 m. (22 ft. 4½ in.) wide at the bottom, and each strengthened by three stiffeners placed 0.900 m. (35½ in.) apart from centre to centre, corresponding to the points of attachment of the three transverse girders which transmit the weight of the bridge to the pivot. Further, inclined stiffeners are provided to transmit the load to the hydraulic lifting jacks, to be mentioned later on. The vertical struts of the main girders are 6.178 m. (20 ft. 3 in.) apart transversely and are connected to the booms by gusset plates varying from 16 to 32 mm. (⅝ to 1¼ in.) in thickness.

The floor girders connecting the main girders are 6.178 m. (20 ft. 3 in.) between centres, their location corresponding with that of the uprights. The part of the structure which, during rotation, transmits to the pivot the whole weight of the bridge (1,450 tons) consists of three heavy plate girders 0.900 m. (35½ in.) apart between centres (Fig. 7, Plate XXXI), their depth varying from 2.282 m. (7 ft. 6 in.) near the girders to 2.500 m. (8 ft. 2 in.) above the pivot. Each member is built up of a web 48 mm. (1⅞ in.) thick, formed of three 16 mm. (⅝ in.) plates, with four 150 by 150 by 16 mm. (5⅞ by 5⅞ by ⅝ in.) angles and flanges built up of plates 500 by 14 mm. (19⅝ by $\frac{9}{16}$ in.), there being five thicknesses of these plates at the centres of the girders. The bottom flanges of these transverse girders are riveted to two flat plates, each measuring 2.30 by 2.30 m. by 14 mm. (7 ft. 7 in. by 7 ft. 7 in. by $\frac{9}{16}$ in.), through the intermediary of which the bracing rests on the pivot-centre cap. The engine-room, which is shown in section in Figs. 7 and 8 on Plate XXXI, and of which a plan is given in Fig. 11 on page 355, is built above the rails over the centre pier, and is provided with two glazed overhanging galleries, from which the man in charge can freely see both the tracks and the canal.

Two vertical shafts, 1.80 m. (5 ft. 11 in.) in diameter, have been provided inside the centre pier and extending through its entire height; the top part of one of the shafts serves as a storage room for the motor spirit required for the engines for swinging the bridge, the second shaft containing a stairway which gives access from the canal to the engine-room. The positions of these shafts are shown in Fig. 12 on page 355, this view being a plan of the top of the pier. The abutments are also provided with internal stairways.

Seeing that the swing bridge will be required to operate but seldom, it was decided that a petrol motor would suffice to give the required motive power, and a 100-h.p. engine has been selected, a similar engine being provided as a stand-by. The engines operate the swing bridge through a Janney variable-speed coupler. The pivot, as shown in the vertical section, Fig. 13, page 355, consists of a lens-shaped block of phosphor bronze, 0.830 m. (32⅝ in.) in diameter and 0.150 m. (5⅞ in.) maximum thickness, placed between two special nickel-chrome steel surfaces. Its lubrication is ensured by a casing filled with castor oil and rendered tight by a leather cup. The pivoting device rests on a cast steel base on the centre pier. The weight of the swing bridge is transmitted to the pivot block by a cast steel centre cap, on which rest the three transverse girders already referred to. The lens-shaped phosphor-bronze block weighs 540 kg. (1,190 lb.); the maximum pressure on the contact surfaces is 1,072 kg. per square centimetre (15,243 lb. per square inch). The cast steel centre cap weighs 12,580 kg. (27,726 lb.) and supports the transverse girders by two plates 14 mm. (0.550 in.) thick. The cast steel base under the pivot weighs 11,580 kg. (25,520 lb.) and rests on a lead sheet 2 mm. ($\frac{1}{16}$ in.) thick on the centre pier. An arrangement (see Fig. 14, page 355), comprising eight hydraulic jacks, of 220 tons each, in sets of two each, operated by a hand pump, has been provided for raising the swing bridge for inspecting the pivoting device and renewing the lubricating oil.

The swinging of the bridge is performed by four special steel pinions which gear in a circular rack. The pinions are in sets of two; they are 481 mm. (about 19 in.) in diameter and have 13 teeth. The rack is of cast steel, built up of 10 sections weighing, together, 14,300 kg. (31,517 lb.); it is 13.320 m. (43 ft. 8 in.) in diameter. The roller path is of cast iron, 12,300 m. (40 ft. 4 in.) in diameter, weighing 22,500 kg. (49,590 lb.). The truncated rollers are 18 in number. The rotation of the bridge is controlled from the driver's stand in the engine-room. The bridge is first unlocked, both at the ends and on the centre pier; the locking devices on the two abutment ends and on the centre pier are coupled together, and work simultaneously under the action of one single pinion which gears in wheels keyed on the locking shafts. Figs. 15 and 16, on page 355, illustrate the locking device on the centre pier. A certain latitude has been provided for in the play of the locking wedges, since, at the moment of locking, the bridge may have to withstand a certain degree of oscillation on the pivot under the influence of strong winds. This is met by the action of spiral springs. Before swinging the bridge the end rails on the two cantilever arms have to be unfished from the end rails on the fixed part of the viaduct.

In order to provide for expansion or contraction due to the great variations in temperature in the district, a gap of 60 mm. ($2\frac{5}{16}$ in.) at zero Centigrade has been provided between the end rails of the swing bridge and the end rails of the viaduct. The trains can run over these gaps at high speed owing to movable fishplates which can be slid into grooves provided at the rail ends on the outside of the track; these grooves are 20 cm. (7⅞ in.) long at the fixed viaduct ends and 72 cm. ($28\frac{5}{16}$ in.) at the swing bridge ends. The wheels of the rolling-stock can thus pass over the gap without any appreciable shock. Each fishplate is under the action of a lever; one bar works simultaneously the four fishplates at each end of the bridge, the bar being under the action of the piston of a compressed air motor supplied with compressed air by an air compressor driven by a 10-h.p. petrol engine, which also supplies the compressed air for starting the main petrol engine for rotating the bridge. The fishplates can also be operated by hand. The bridge can also be revolved by hand, this operation requiring 13 men. The views, Figs. 17 and 18, on page 358, show the swing bridge open.

When the swing bridge is locked the ends of its cantilever arms rest on a jointed eccentric device on the abutments, and before the bridge is made to swing open, when the movable fishplates have been drawn back, the bearings on the abutments have to be unlocked. Each of the locking devices consists of a quadrant fitted on the eccentric pins of a shaft, the intermediate portion of which supports the platform. The four locking apparatus are coupled two by two and are operated simultaneously. When the swing bridge is unlocked there is a 50 mm. (2 in.) play between the sectors and the bearings, so that there is always a sufficient gap for the swinging even in case of an abnormal sag at the ends of the girders. These latter have, moreover, been built with a counter sag. For re-locking the bridge when it is closed again it is sufficient to operate the eccentric quadrant. A vertical locking device stops the bridge when it is finally closed and maintains it in a line with the viaduct. Before the final opening and the final closing the transmission gear is automatically stopped and the vertical locking device, when closing the bridge, comes into play automatically, a system of springs being provided to deaden the shock of the vertical lock-bolt. The horizontal locking device contains, at its top part, a lock-bolt which moves in a slide; this insures that the tracks are in perfect alignment when the swing bridge is closed.

For opening the bridge, the engine driving the Janney apparatus is first started running, the tracks are unfished and the bridge unlocked simultaneously, the engine is coupled up with the transmission gear, and the bridge opens within about 6 minutes from the time operations were started. All the actions succeed each other in a given order, any one of them cannot commence until the preceding one is completed, and no manœuvre in the engine-room for opening the bridge can take place until the station-masters of the nearest stations on both sides of the viaduct have closed the line in the direction of the viaduct. Moreover, the man in charge in the engine-room over the centre pier cannot start the engine for swinging the bridge until he also has closed the signals protecting the bridge.

Adequate means have been taken to insure all the steel parts of the swing bridge against the corrosive action of the damp atmosphere. In the first place, great care has been exercised in the selection of the angles entering into the construction of the built-up girders, the outer sides of the angles ending up sharp and in a perfectly straight line without any outside bevelling at the ends. Two small tracks have been provided, one which enables the inspection of the lower portion of the swing bridge platform to be carried out, the other being located on the top of the main girders for inspecting the upper part of the swing bridge structure. This upper track contains a rack on which runs the inspection traveller shown in the vertical sections through the swing bridge over the centre pier, Figs. 7 and 8, Plate XXXI. There are provided on the traveller four buckets, two large ones for inspecting the outside portions of the girders and two small ones for visiting the inside of the structure.

(To be continued.)

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Nothing has happened during the week to relieve the monotony concerning the pig-iron warrant market—matters still stand in the same position as they did last Wednesday. Stocks in store are gradually being depleted.

Scotch Steel Trade.—Notwithstanding the fact that every rolling-mill in the West of Scotland is running to an extent never attempted hitherto, it seems scarcely possible for the local steel-makers to overtake the demands made upon their plant. The requirements of the Ministry of Munitions and of the Admiralty must be met, and at the same time the Allied Governments, more particularly those of France and Italy, are clamantly asserting their necessities. One important factor which militates against this latter pressure being fully met is the increasing difficulty of obtaining licences for the export of steel and other metals. As the result of the various extensions which have recently been put through by a number of producing works in the district, it is confidently expected that makers will very shortly find themselves in a position to add considerably to their already exceptionally heavy output. Meantime, all over, the attitude continues firm, prices maintaining a decidedly upward tendency. Steel ship-plates are still quoted 14*l.* per ton and up, according to thickness; boiler plates are 15*l.* 2*s.* 6*d.* and up; and angles fully 14*l.* 7*s.* 6*d.* per ton.

Malleable Iron Trade.—Malleable iron workers continue to experience working conditions of extreme activity with machines of every description running incessantly—the wonder being how the finished material can all be used up. Quotations keep high, and although the lowest rate being asked for "Crown" bars is 13*l.* 7*s.* 6*d.* per ton, much higher prices are being demanded and paid for the better qualities.

Scotch Pig-Iron Trade.—In the local pig-iron trade conditions are much on the same level as they were a week ago—hematite in exceptionally heavy demand and ordinary foundry grades moving away readily. As has been the case for some time now, the entire output is being speedily consumed by steel-makers in the immediate vicinity. This, naturally, is increasingly curtailing any supplies available for export, even were it possible to obtain licences. Certainly under the present restricting system the future outlook of the export trade seems none too alluring. It may be, however, that in due course the controlling hand of Government may be slightly slackened, but in the meantime it is absolutely necessary that every effort must be made to reserve as much of the tonnage as possible for the local works engaged directly or indirectly on munitions and other war requirements. To increase the output is the strenuous endeavour of every maker of pig-iron. Prices remain much on the level of the past two or three weeks.

SPIEGELEISEN.—The exports of spiegeleisen, ferro-manganese, and ferro-silicon from the United Kingdom amounted in August to 16,907 tons, as compared with 9,745 tons in August, 1915, and 5,902 tons in August, 1914. In the eight months ended August 31 this year the aggregate exports were 91,633 tons, as compared with 66,710 tons and 75,454 tons.

THE JUNIOR INSTITUTION OF ENGINEERS.—The winter session of this Institution commenced on Friday last, October 6, when Mr. E. Eade opened the series of Friday evening "informal discussions," taking for his subject "Stability and Use of Cranes under Working Conditions." During October similar lecturettes will be given on "The Principles and Application of the Oil Engine," by Mr. W. H. Abrahams; and "Time Saving as a Science," by Mr. A. H. Stanley. The ordinary monthly meeting will be held on Wednesday, October 18, when Mr. Frederic H. Taylor, A.M.I.E.E., A.M.I.Mech.E., will read a paper on "Industrial Lighting by Electricity." A special series of five lecturettes will be given on alternate Friday evenings from October 20 by Mr. E. Fiander Etchells on:—"A Common-sense Notation for Engineers"; "The Practical Use of Units in the Evaluation of Formulæ"; "How to Memorise Formulæ"; "Logic of the Differential and Integral Calculus"; "Practical and Illustrative Examples of the Application of the Newer Concepts."

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Hull Coal Traffic.—Although the coal traffic at the Humber port for the month of September was about up to the average of the similar periods of this year, it showed a marked diminution on the trade for the corresponding month of last year, both in regard to the tonnage received and exported. A total of 316,467 tons was forwarded, being a decrease of 109,135 tons. The aggregate tonnage for the year up to date is 2,529,199 tons, a decline of 1,174,874 tons. Foreign exports amounted to 94,369 tons, a decrease of 170,000 tons, which makes the total up to the present 50 per cent. of the figures for last year. The bulk of the traffic went to France, Italy and Sweden, the former taking almost half, though she only received 44,231 tons, as against 120,000 tons last year. Italy received 15,135 tons, compared with 6,434 tons, and Sweden 19,029 tons, against 43,541 tons. These figures are exclusive of coal shipped for the use of the Allied Governments. Denaby and Cadeby Main Collieries were the chief sources of supply with 47,514 tons. Increases were shown by Manvers Main, Maltby, Rotherhithe, and Welbeck collieries.

South Yorkshire Coal Trade.—Best steam and hard coal pits are once again severely taxed to cope with the inrush of orders, for a heavy demand is made upon their output by the requirements of railway consumers, manufacturers, and for shipping purposes. The stocks accumulated during the works' holidays have been entirely depleted. Cobbles, nuts and slacks still maintain a strong position, and to all outside appearances the open market has nothing to offer, the total production being sold under contract some considerable time ago. A good demand prevails for bunkers. Export sales are transacted at higher figures, but the licensing restrictions make this class of trade increasingly difficult. Cokes of all classes are hard to obtain, and the full prices have to be paid. The activity displayed by gas producers has tightened up the house coal market to a marked degree. Quotations :—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire best brights, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire house, 16*s.* to 17*s.*; best large nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; small nuts, 15*s.* to 16*s.*; Yorkshire hards, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; smalls, 8*s.* to 9*s.*

Iron and Steel.—There has been some improvement in the material market, due in a large measure to quite unexpectedly heavier arrivals of the Swedish brands, particularly of common irons. Steel and bar iron are not such good deliveries, though they, too, are infinitely better than they were. English pig-iron does not show much alteration. The maximum prices scale terminated at the end of September, but a new one is yet wanted, and it may be forthcoming during the latter part of this week. All brands of Lincolnshire pig-iron are marked at 97*s.*, with delivery at the works. Derbyshire forge fetches 93*s.* 6*d.* and foundry 95*s.* 6*d.*, and in some cases a trifle higher. There is not, however, a very pressing demand for the foundry qualities. The changing of furnaces from foundry smelting to steel-making iron is expediting and enlarging the production of pig-iron. The demand for hematites, both for home and export, is enormous. Foreign customers willingly pay 142*s.* 6*d.* for East Coast, with prompt delivery, but in Sheffield the price is 122*s.* 6*d.*, with delivery here. Latest quotations are Bessemer acid steel, 14*l.*; Siemen's, 15*l.*; basic hard, 12*l.* 10*s.*; basic soft, 12*l.* 10*s.*; hoops, 17*l.* 2*s.* 6*d.* to 18*l.* More basic steel is required. There is an easy tone about the scrap metal market, and supplies are to be had in abundance. The general engineering trade of the city is extremely busy, the full capacity of the plant and workmen being required. Tramway orders are substantial, Messrs. Edgar Allen's having two large contracts on hand. The file-makers have an opportunity of wiping off contract arrears, seeing they have almost entirely fulfilled the large Russian Government orders. Cutlery manufacturers are pressed for three things : Army supplies, export orders and the better qualities of their products for the home market. New stainless cutlery meets a heavy demand from the United States. Overseas orders are for tools, steel, files, spades, railway plant and wire rope.

Sheffield Trade Matters.—Messrs. Kayser, Ellison and Co., steel and tool manufacturers, of Sheffield, report that, after making provision for war taxation, there is a balance on last year's working of 45,811*l.* 13*s.* 5*d.* After the payment of the full yearly dividend on the preference shares (6,000*l.*), and an interim dividend on the ordinary shares of 5*s.* per share, for the six months ending December 31, 1915 (5,250*l.*), and placing 5,000*l.* to employees' benefit fund, there is 29,561*l.* 13*s.* 5*d.* to dispose of. It is proposed to pay a final dividend of 7*s.* 6*d.* per share on the ordinary shares, making 12½ per cent. for the year, plus a bonus of 7*s.* 6*d.* per share, both free of tax, and to carry the balance of 13,811*l.* 13*s.* 5*d.* forward to next year. In 1912–13 the dividend was 20 per cent., and in the last two years 15 per cent. The directors report that they are a "controlled" firm, and the plant and machinery have been kept working at increased speed and continuously night and day to cope with the Government requirements. This has been done without the usual stoppages, and to cover the consequent excessive wear and tear 10,000*l.* has been set aside.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Trade.—There are substantial inquiries for Cleveland pig-iron. A fairly large business with home foundries is reported, with orders coming in for delivery to the end of the year where makers are in a position to execute them. Buyers north of the Tweed are anxious to purchase over November, but as yet they are restricted to placing orders for delivery this month. So far as the foreign trade is concerned there is continued extensive buying for France, and licences are coming forward for shipment to Italy and Russia. For home consumption No. 3 Cleveland pig stands at 87*s.* 6*d.*, and that figure also rules for No. 4 foundry and for No. 4 forge; whilst No. 1 is put at 91*s.* 6*d.* The export quotation for No. 3 ranges from 97*s.* 6*d.* to 100*s.*; and No. 4 foundry is 96*s.* 6*d.*, No. 4 forge 95*s.* 6*d.*, and No. 1 102*s.* 6*d.* for shipment abroad. Any warrant iron coming on the market for prompt shipment readily realises 100*s.*, and, indeed, it is difficult to find holders prepared to accept that figure.

Hematite Iron.—New business in East Coast hematite iron continues very difficult to arrange. Stocks are practically nil, and makers are so full of orders that they can hardly fulfil their obligations to customers who have purchased. Deliveries on running contracts are heavy. Mixed Nos. remain at 122*s.* 6*d.* for home use and for shipment to France, and 140*s.* and upward for general export.

Stocks and Shipments of Pig-Iron.—Stocks of pig-iron now stand at 9,814 tons, composed of 9,778 tons of No. 3 quality and 36 tons of other kinds of iron deliverable as standard. So far this month the stock has been reduced by 2,776 tons, all No. 3 quality. Shipments of pig-iron from the port of Middlesbrough so far this month amount to 13,302 tons, as compared with 15,343 tons to the same date last month, and 15,814 tons for the corresponding part of October last year.

Coke.—There is no change in coke. Local demand keeps heavy, but supply is much more than ample. Average blast-furnace qualities are still 28*s.* at the ovens, and up to 30*s.* 6*d.* at the ovens continues to be named for low phosphorus sorts.

Foreign Ore.—Large quantities of foreign ore continue to come steadily to hand, with the result that consumers' already very heavy stocks are being substantially added to. Imports to the Tees so far this month reach 76,679 tons.

Blast-Furnacemen's Wages.—The average net selling price of No. 3 Cleveland pig-iron for the third quarter of the year has been certified at 87*s.* 11.31*d.*, as compared with 81*s.* 5.96*d.* for the previous three months, and under sliding-scale arrangements blast-furnacemen's wages are advanced by 8 per cent., raising them to 69.75 per cent. above the standard.

Manufactured Iron and Steel.—There is little or no change to report with regard to the various branches of the finished iron and steel industries. Manufacturers are still too fully engaged on Government work to pay much heed to private inquiries, and consequently ordinary commercial business continues very largely neglected. Prices all round are fully maintained. The following may be given as among the principal market quotations : Common iron bars, 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; double best bars, 14*l.* 10*s.*; treble best bars, 14*l.* 17*s.* 6*d.*; iron ship plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 17*l.* 10*s.* to 18*l.* 10*s.*; packing iron and steel (parallel), 11*l.*; packing iron and steel (tapered), 13*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.*; steel joists, 11*l.* 2*s.* 6*d.*; steel strip, 17*l.*; heavy sections of steel rails, 10*l.* 17*s.* 6*d.*; and steel railway sleepers, 12*l.*

Manufactured Iron-Workers' Wages.—The accountants to the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England have certified the average net selling price of iron plates, bars and angles for the two months ending August 31 last at 12*l.* 7*s.* 0.14*d.* per ton, as compared with 11*l.* 17*s.* 5.54*d.* per ton for the previous two months, and in accordance with sliding-scale arrangements there is an advance of 6*d.* per ton on puddling and 5 per cent. on all other forge and mill wages.

Formation of Iron and Steel Merchants' Association.—The North-East Association of Iron and Steel Merchants has just been formed. The objects of the Association are to watch, through its committee, any proceedings affecting the interests of the trade, to protect its members against any frivolous, vexatious or malicious prosecution, to retain to them the full and free exercise of their trade as iron and steel merchants, and to oppose all innovations, exactions and restrictions upon the trade which the committee may think calls for interference. The entrance fee is 50*l.*, and the annual subscription 2*l.* 2*s.* Mr. Ralph Hughes, of the firm of Messrs. Hughes, Bolckow and Co, is president; Mr. Wm. Blenkinsop, vice-president; Mr. Thos. Brown, Royal Exchange, Middlesbrough, secretary; and Mr. C. J. Sambidge, Lloyd's Bank, Middlesbrough, treasurer.

NOTES FROM THE SOUTH-WEST.

Cardiff.—Heavy stocks of coal are reported to be standing; this is principally attributable to delays in the arrival of engaged steamers, occasioned by stormy weather Notwithstanding this, licences for export, to neutral countries have been obtained with difficulty. There is still an absence of information concerning the limitation scheme for Italy, and this has checked forward business. Concessions have been obtainable for cheap grade coal for immediate shipment, but quotations for all other qualities have been maintained. Smalls have been in fairly good supply. House coal, patent fuel and coke have shown scarcely any change. The best Admiralty large steam coal has been to some extent nominal; secondary qualities have made 39*s.* to 48*s.*; Monmouthshire Black Veins, 40*s.* to 41*s.*; ordinary Western Valleys, 39*s.* to 40*s.*; Eastern Valleys, 37*s.* to 38*s.*; best bunker smalls, 28*s.* to 29*s.*; and cargo smalls, 20*s.* to 25*s.* per ton. In bituminous coal, best households have made 25*s.* 6*d.* to 26*s.* 6*d.* at the pits; No. 3 Rhondda large, 40*s.* to 41*s.*; smalls, 30*s.* to 32*s.*; No. 2 Rhondda large, 32*s.* to 34*s.*; and No. 2 smalls, 24*s.* to 25*s.* per ton. The latest quotation for patent fuel has been 43*s.* to 45*s.* per ton. Special foundry coke for export has brought 62*s.* 6*d.* to 65*s.*; good foundry coke, 60*s.* to 62*s.* 6*d.*; and furnace coke, 50*s.* to 55*s.* per ton.

Western Trade Matters.—Mr. W. North Lewis has been appointed managing director of Insoles, Limited.—The directors of the Nautilus Steam Shipping Company, Limited, recommend a dividend and bonus of 31½ per cent. for 1915–16; the corresponding distribution for 1914–15 was 12½ per cent.; for 1913–14, 10 per cent.; for 1912–13, 8 per cent.; for 1911–12, 6 per cent.; and for 1910–11, 5 per cent. The profits for each of the five years were :—1910–11, 13,591*l.*; 1911–12, 35,063*l.*; 1912–13, 61,645*l.*; 1913–14, 58,511*l.*; 1914–15, 88,566*l.*; and 1915–16, 165,544*l.*—Lord Rhondda has contradicted a statement that he is associated with a group which proposes to acquire a controlling interest in the Britain Steamship Company.—The period for the availability of September export coal licences was extended to October 7; the French Coal Committee agreed to grant an extension to licences from the Swansea district, but the War Trade Department says :—"No general extension can be allowed for other parts. Individual cases put forward by the local committee to the French Coal Committee would be considered on their merits."—The annual meeting of the Port Talbot Graving Dock and Shipbuilding Company, Limited, was held at Port Talbot on Thursday, Mr. W. Mordey in the chair; a dividend of 10 per cent., free of income-tax, was declared for the past financial year, a reliquat of 4,793*l.* being carried forward.—The Town Line, Limited, has declared an interim dividend of 5*s.* per share (20 per cent. per annum), free of income-tax, for 1916–17; the local managers are Harrison, Sons and Co., Cardiff.—Lord Rhondda, president of the Cardiff Business Club, attended a meeting of that body on Thursday to hear an address by Mr. Stanton, M.P., on the "Great Awakening"—after the war. Lord Rhondda said he believed the country was not going back on much that existed before the war. The lawyers and the people who could talk would still sway the crowd and win votes; what business men ought to do was to exercise their influence on the Cabinet and see that it behaved in a businesslike manner; the various local committees which had been appointed would endeavour to stop German dumping; Britishers were more than a match for Germans in brains, general intelligence, invention, and in every other respect.—Mr. Runciman, president of the Board of Trade, had an interview on Thursday with representatives of Welsh coal owners on the question of the supply of coal to Italy; satisfactory arrangements were agreed to with regard to freights for Mediterranean ports.—A meeting of a joint sub-committee appointed by the South Wales Conciliation Board to deal with the question of absenteeism at collieries was held at Cardiff on Friday; returns supplied from different collieries were considered, and the committee decided unanimously to urge strongly upon all parties that every effort should be made to secure the largest possible coal output.—A meeting of Bristol engineering firms decided that the local authorities should be requested to initiate a junior technical school for the training of boys intended to devote themselves to engineering; the employers represented undertook to offer employment to any suitable boys so trained.—Mr. W. Bund, presiding at a meeting of the Severn Board of Conservators, said it was proposed to bring into Chepstow a very large number of workpeople and to build a garden city; the whole of the refuse and sewage from the works and residences would go into the Wye and thence into the Severn. Lord Crawford spoke sympathetically, but said he was in a difficulty because the Treasury regarded the shipbuilding project as of national importance, and was supported in this view by the Board of Trade and the Local Government Board.—The directors of the Swansea Wagon Company, Limited, recommend a dividend of 3*d.* per share free of income-tax, carrying at the same time 959*l.* to rolling-stock depreciation account.

United States Pig-Iron Production.—According to a bulletin recently published by the American Iron and Steel Institute, the United States produced during the first six months of the current year 19,347,935 tons of coke pig-iron, as compared with 17,473,500 tons in the second half of 1915. Including charcoal pig-iron, anthracite, and mixed anthracite and coke pig-iron, the total production of pig-iron for the first half of the current year amounted to 19,610,522 tons. The larger proportion was basic pig-iron, to the amount of 8,830,085 tons, followed by 6,839,177 tons of Bessemer low-phosphorus pig, and 3,086,410 tons of foundry pig.

Russia's Naphtha Production.—The Russian naphtha production amounted to 557,000,000 poods in 1914, to 571,000,000 poods in 1915, and to 251,000,000 poods during the first five months of the current year, against 244,000,000 poods for the corresponding period of the preceding year. This increase was obtained in spite of the closing down of the Maikop oilfields. The transport of the naphtha was less hampered than that of the coal, for the large naphtha companies own sufficient tank-wagons. In addition to this, the railways connected with the naphtha districts were much less taken up by military transport than were those farther west. (1 pood = 36 lb.)

THE SWING BRIDGE OF THE CARONTE VIADUCT, SOUTH OF FRANCE.

CONSTRUCTED BY MESSRS. SCHNEIDER AND CO., ENGINEERS, CREUSOT AND CHALONS-SUR-SAÔNE.

(*For Description, see Page* 355.)

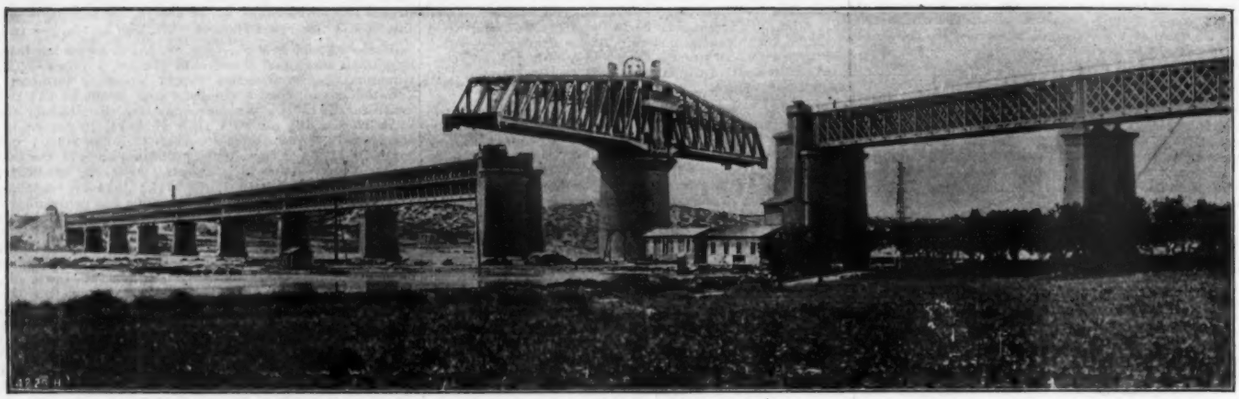


Fig. 17.

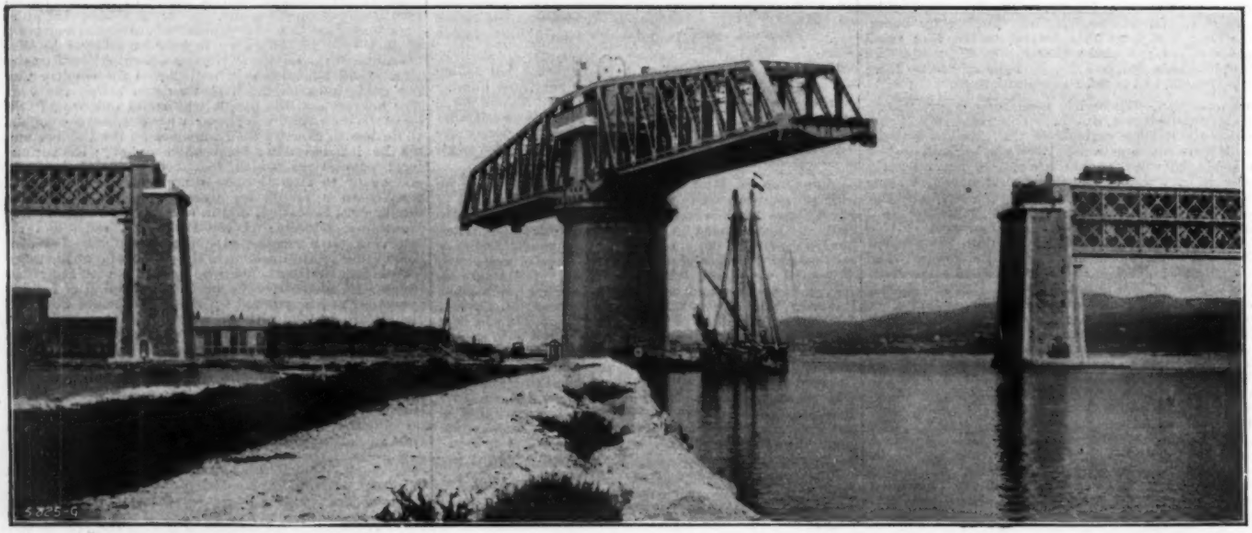


Fig. 18.

Contracts.—Messrs. The Mirrlees Watson Company, Limited, Glasgow, state that they have recently received orders for 34 sets of condensing plants, practically all for war service work, and of varying steam duties up to 130,000 lb. steam per hour.

Prohibited Exports.—A supplement to the *Board of Trade Journal* of the 12th inst. contains complete lists of articles which, according to the latest information received by the Board of Trade, are prohibited to be exported to various destinations from British India, Canada, New Zealand, South Africa, Newfoundland, Egypt, Malta, Cyprus, Mauritius and Ceylon. The supplement may be obtained from the usual sale agents for Government publications at the price of 3½*d.* post free.

Personal.—Mr. W. A. Tookey requests that correspondence should be directed to 39, Victoria-street, Westminster, S.W., and not to 212, Upper Thames-street, E.C., as hitherto.—Mr. J. F. Nauheim has retired from the chairmanship of the British Thomson-Houston Company, Limited, Rugby. The managing director, Mr. H. C. Lewis, was appointed chairman of the Board and also retains the managing directorship of the company.—Mr. Hugh Girvan, 120, Cannon-street, London, E.C., has been appointed sole agent in Great Britain by the Dominion Sheet Metal Company, Limited, Hamilton, Ontario, for the sale of their galvanised corrugated and flat sheets.

Spelter Manufacture: Erratum.—Owing to some confusion between commas and decimal points the figures given in the letter on "Spelter Manufacture" in our last week's issue (page 337) were misleading. The letter should have read: "We require to produce 38,500 tons of metal 100,100 tons of ore. If we take 45 per cent. to represent the average contents, the total zinc in the above-mentioned quantity will equal 45,045 tons, so that the actual tonnage of unrecovered zinc is 6,545 tons, as shown in the following:—

	Tons.
Total zinc content in 100,100 tons of ore	45,045
Quantity actually recovered for the market	38,500
Quantity unrecovered, shown as working loss	6,545

. . . If we assume the capacity (of furnace) to be one of, say, about 14 tons per week, it would require approximately 53 furnaces to produce the quantity quoted, viz., 38,500 tons." Also 130.9*l.* should be 130,900*l.*

The late Mr. Robert Gobat.—We regret to hear of the death after long illness of Mr. Robert Gobat, for some time chief engineer of the Jungfrau Railway. Gobat was only 50 years old when he died in Switzerland. Born in the Bernese Jura he was educated at the University of Geneva and then in the Engineering Department of the Polytechnical Zürich. After taking his diploma he was for nearly 10 years, till 1898, engaged in prospecting and building sections of the Swiss North-East Railway. In 1898, he was appointed chief engineer of the Jungfrau Railway, then under construction, which meant that he spent several winters high up in the mountains. When the Institution of Electrical Engineers paid a visit to Switzerland in 1899, he was their guide over the line and the electrical plant then being installed, though few knew that the kindly, modest retiring man bore the responsibility for the operations. Later he joined the Albula Railway and had to supervise the construction of tunnels, hydroelectric power stations, &c.; later on he became a partner in the firm of Müller & Zeerleder, of Zürich, which had undertaken these constructions.

Special Entry Naval Cadetships for the Royal Navy.—The Secretary of the Admiralty makes the following announcement:—"About 50 cadetships (special entry) will be offered for competition at the examination to be held by the Civil Service Commissioners conjointly with the Army Entrance Examination for Woolwich and Sandhurst in February next. Candidates are required to be not more than 18½ nor less than 17½ on December 1, 1916. Candidates who competed unsuccessfully at the examination in June, 1916, and are still eligible as regards age, will be allowed a further opportunity to compete. Similarly candidates who fail on the present occasion will be allowed to compete again in June, 1917, provided they are still eligible as regards age. Candidates who have served with His Majesty's Naval or Military forces during the war will be allowed a deduction from actual age in respect of such service. To receive this concession, candidates must furnish an official certificate as to the period of their service. The syllabus of subjects of examination and further particulars may be obtained from the Secretary of the Admiralty, Whitehall, S.W. Forms of application, to be filled in by the parents or guardians of candidates, will be furnished on application by letter addressed to the Secretary of the Admiralty. The forms should be completed and returned to the Secretary of the Admiralty not later than December 25, 1916.

THE SWING BRIDGE OF THE CARONTE

CONSTRUCTED BY MESSRS. SCHNEIDER AND CO., ENGIN

(For Description, see P

Fig. 1. PART ELEVATION

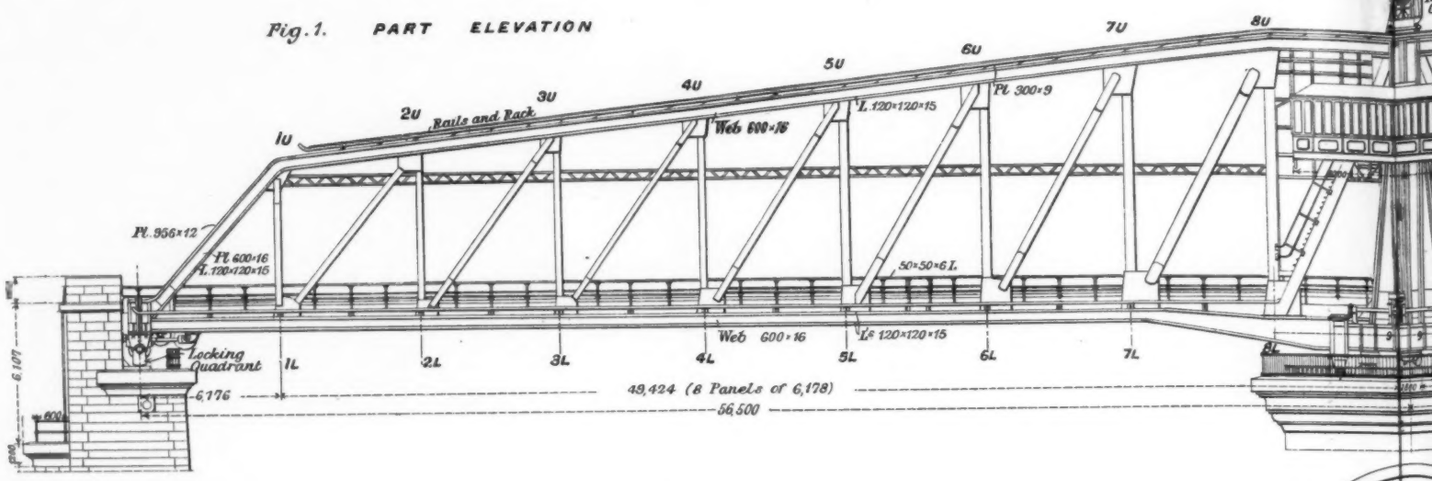
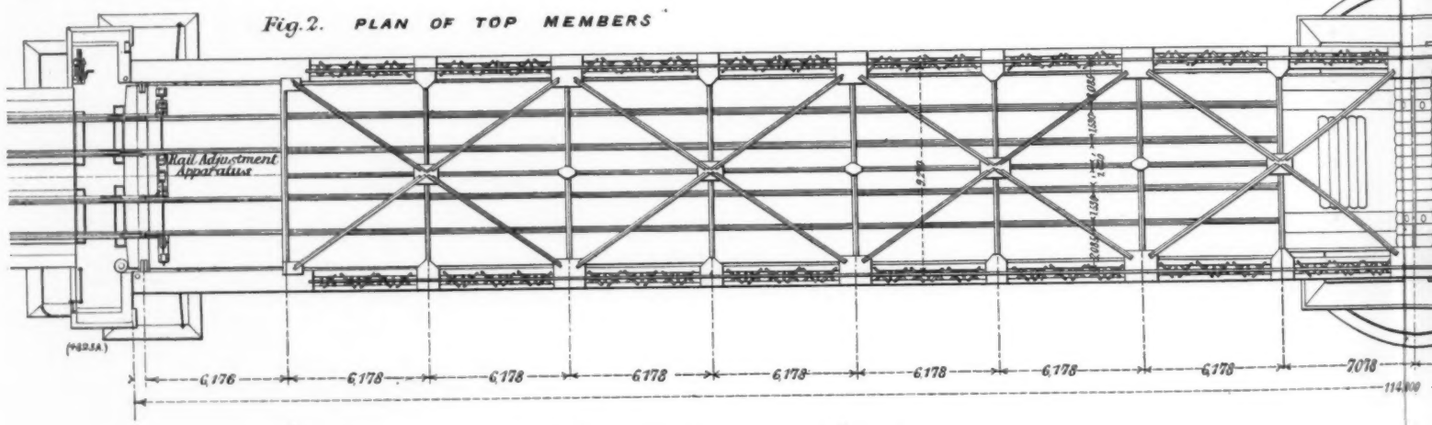


Fig. 2. PLAN OF TOP MEMBERS



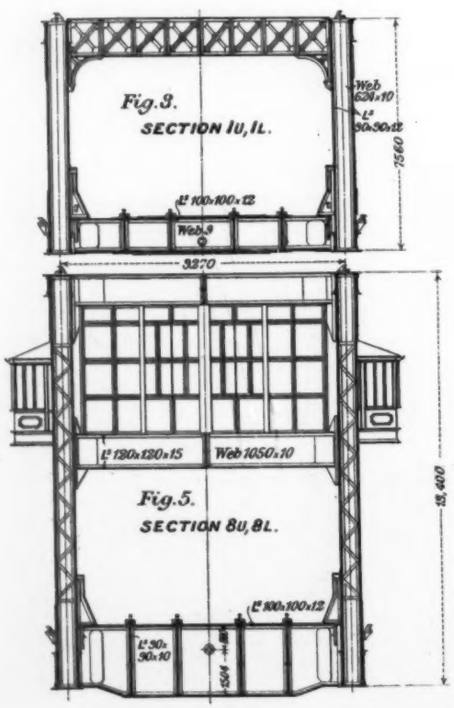


Fig. 3. SECTION 1U, 1L.

Fig. 5. SECTION 8U, 8L.

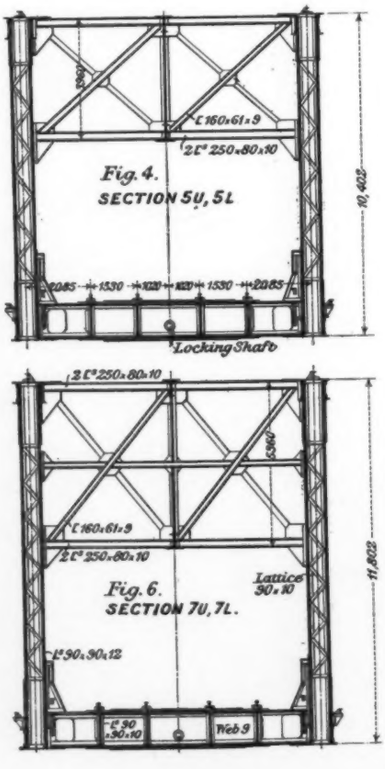


Fig. 4. SECTION 5U, 5L.

Fig. 6. SECTION 7U, 7L.

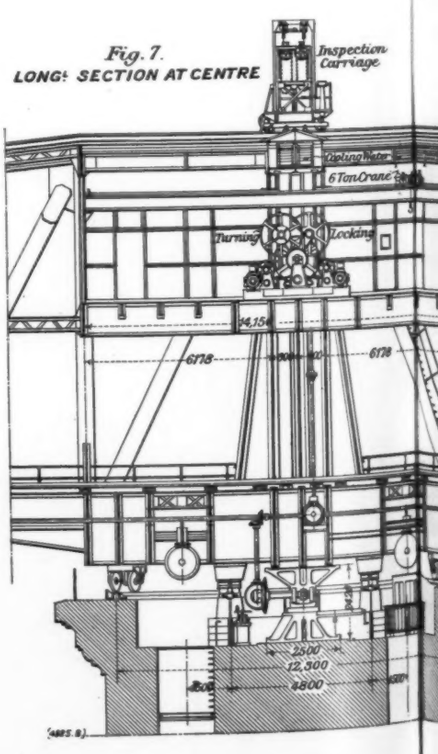
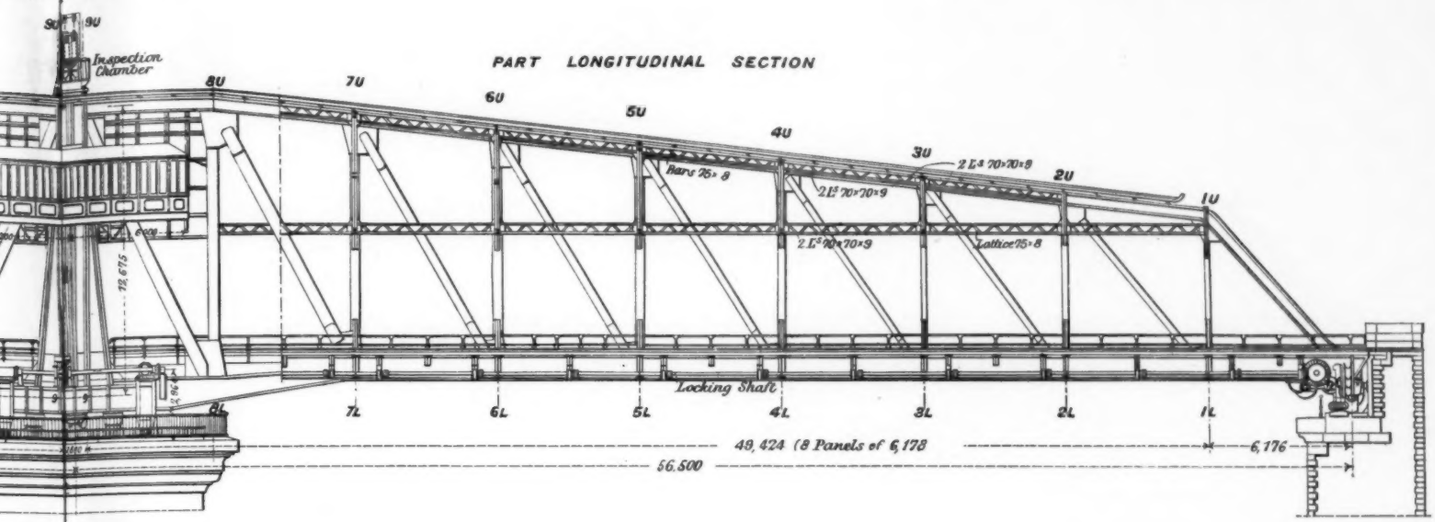


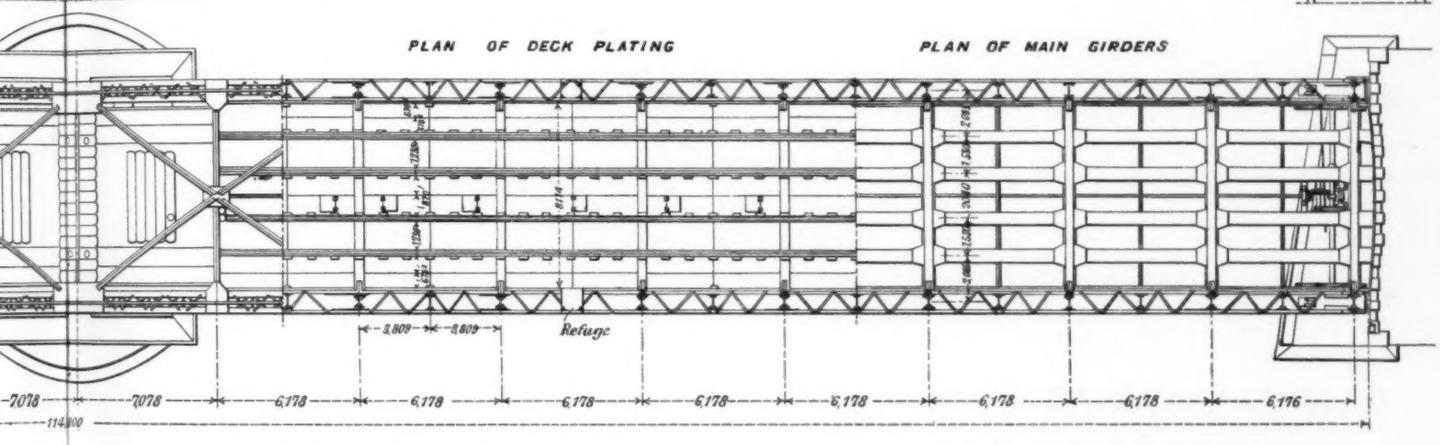
Fig. 7. LONG^L SECTION AT CENTRE

ARONTE VIADUCT, SOUTH OF FRANCE.

ND CO., ENGINEERS, CREUSOT AND CHALONS-SUR-SAÔNE.

(Description see Page 355.)





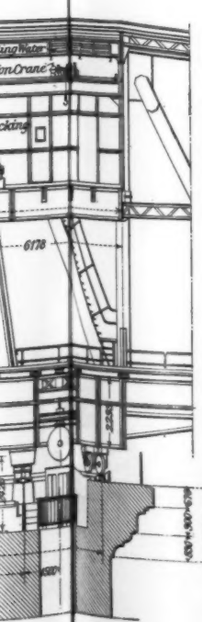


Fig. 8. CROSS SECTION AT CENTRE

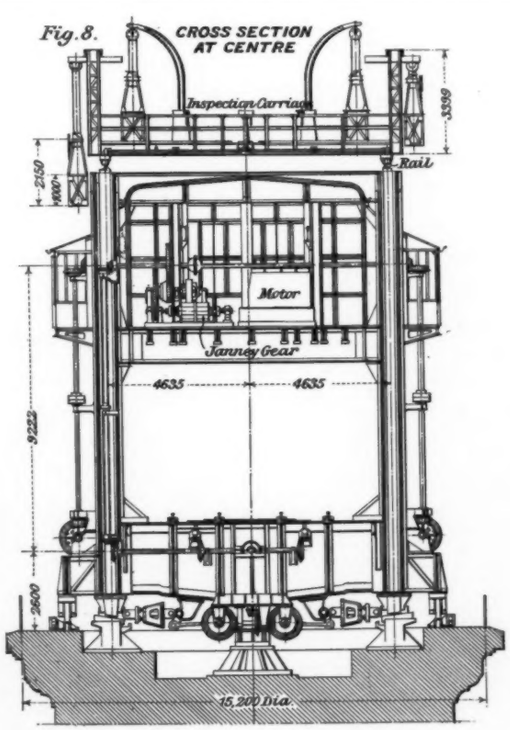


Fig. 9.

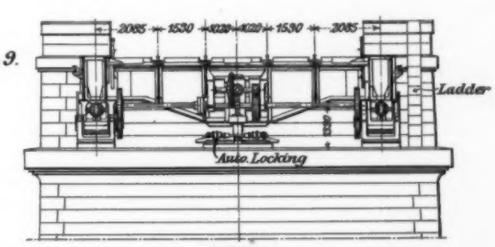
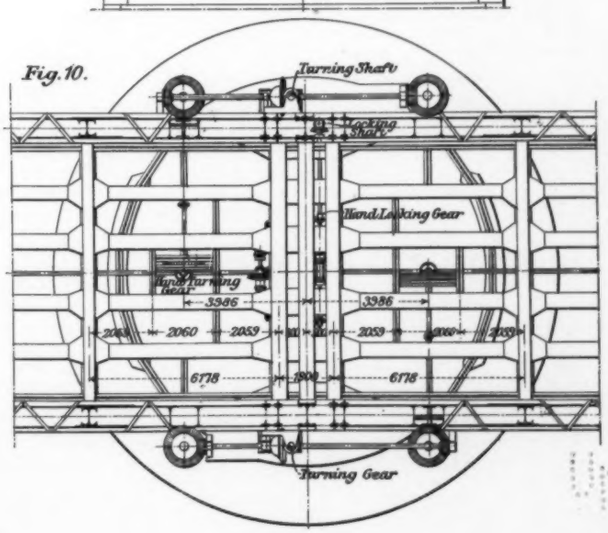


Fig. 10.



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The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

SUBSCRIPTIONS, HOME AND FOREIGN.

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Thick "	£1	16	6 ($8.75)
For all other places abroad—			
Thin paper copies	£1	16	6
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Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C.

Offices for Publication and Advertisements, 35 and 36, Bedford-street, Strand, London, W.C.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3663 and 8596 GERRARD.

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With a Two-Page Plate of the SWING BRIDGE OF THE CARONTE VIDUACT, SOUTH OF FRANCE.

NOTICES OF MEETINGS.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Saturday, October 14, the opening lecture of session 1916-17 will be given in the Assembly Room of the Cycling Club, Cavendish-street, by Mr. J. Judson, of the Judson-Jackson Company, Limited, London and Birmingham. Subject: "Sales Methods" (illustrated by numerous slides). Chair to be taken at 6.45 p.m. by the President, Mr. J. A. E. Mitchell.

THE MANCHESTER ASSOCIATION OF ENGINEERS.—Saturday, October 14, at 7 o'clock, at the Grand Hotel, Manchester. Inaugural address by the President, Mr. F. W. Reed, M.I.Mech.E.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Tuesday evening, October 17, at 8 o'clock, at the House of the Royal Society of Arts, John-street, Adelphi, W.C. The following paper will be read:—"The Norfolk Oil Shales," by Mr. William Forbes-Leslie, M.B., F.G.S. The chair will be taken by the President, Professor John Cadman, C.M.G., D.Sc., M.Inst.C.E.

THE JUNIOR INSTITUTION OF ENGINEERS.—Wednesday, October 18, at 7.30 p.m., at the offices of the Institution. A paper entitled "Industrial Lighting by Electricity" will be read by Mr. Frederic H. Taylor, A.M.I.Mech.E., A.M.I.E.E.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, October 20, at the Institution of Civil Engineers, Great George-street, Westminster, at 6 p.m. Paper:—"Trials on a Diesel Engine, and Application of Energy Diagram to obtain Heat Balance," by the late Lieutenant Trevor Wilkins, M.Sc., Graduate. To be presented by Professor Burstall, of Birmingham.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, OCTOBER 13, 1916.

THE ECONOMISING OF LABOUR WITH INCREASE OF WORKERS' EARNINGS.

THERE is no problem in industry so vitally important as the economising of labour to ensure the maintenance of the maximum rate of output from men as well as mechanical appliances. This is especially the case during the war, as the cry for munitions is still, and must continue to be, clamant, since they are essential to success, and particularly to the saving of the lives of those fighting for the final overthrow of our enemies. It is also important so far as concerns manufacturing now and in the future productions for export, so that the monetary cost of the war may be met without delay. It may at once be admitted that the workers are showing a fuller appreciation of the need now of such maximum efforts, but there still is entertained the view that the pre-war trade-union regulations restricting output are justified, and this, it is said, is founded on a lack of confidence by workers in the staff of employers, who, it is urged, are too prone to cut rates when the men make high earnings. Any proposal which makes this rate-cutting unnecessary is, therefore, worthy of consideration. What is wanted is a greater degree of fixity in rates in order to ensure fuller confidence on the part of the worker that his earnings will be proportionate to his efforts and to his ingenuity in the direction of economising labour, and, further, that there will be no attempt to exploit augmented effort. This end should be the more easily achieved, as high earnings due to the continuous working of expensive mechanism is conducive to economy in production as well as courage in adopting improved machine appliances. A method of solving the difficulty and the results of its application were described with completeness in a paper by Mr. R. Rankin, read last session at the Junior Institution of Engineers.

The system adopted was that known as the Harrington-Emerson, which, in essentials, consists of paying the workman so much per hour for accomplishing a set task, and so much per piece when the set output is exceeded. The greater the workman's output the greater his hourly rate of pay. In order to fix the task fairly, much investigation was necessary, and in the course of this investigation it was found that a great deal of unskilled labour was being done by the skilled men. Thus in fitting work to a template and subsequently joining the pieces together it was found that of a total average time of 11 minutes 15 seconds per piece only 38 per cent. was spent in skilled labour. The work was accordingly rearranged. Four skilled men were united into a gang, each provided with a boy assistant, who removed the completed articles and cleaned up for the whole gang. At the same time a certain amount of carrying of the work from one place to another was abolished and some alterations made to the template and tools to give greater ease in handling and to reduce risk of accidental damage. The result was that whilst 2.37 completed pieces of work per skilled man per hour had been the average, the output was raised to 11 or 12 per hour. The minimum rate of pay was 20 per cent. more than previously, but the labour cost of the work was reduced by 63 per cent. In another case in which certain work had been wholly done by skilled men the attempt to take times met with much obstruction, but the records made showed that of the total time taken only about one-sixth was spent on skilled work proper, the rest being devoted to carrying and placing parts, setting up and dismantling tools, &c. It was found accordingly that by altering methods one skilled man could keep two labourers going. The attempt to introduce this change, however, met with obstruction on the part of a foreman, and it was decided accordingly to modify the proposal and provide one labourer to two skilled men. Ultimately semi-skilled men were employed for the whole work, the reduction in cost being 66 per cent. In another case the output before the introduction of improved methods had averaged 60 pieces per hour; under the new system it was 132, the consequent reduction in the labour cost per piece being 19 per cent. Still more striking was one case in which the output was increased from 6 per hour to 36, the decrease in labour cost being in this case 66 per cent.

Commenting on these and other similar figures given in his paper, Mr. Rankin observed that in any attempt to realise economies of this kind the reformer should recognise that trouble is inevitable, and the attempt should not be made unless he is prepared to see it through. Thus in one department, employing a large number of semi-skilled men, the average output was 6.5 pieces per hour. Time and motion studies, which were strongly resented, showed that by a fairly simple rearrangement the output could be raised to 15 per hour, and by further subdivision and the employment of unskilled labour to assist the output could be raised to 30 pieces per hour per semi-skilled man. A squad set to work on this system experimentally, turned out, much to their own dismay, 29 pieces per man per hour over the whole day. The consequence was a threat of a strike and a demand for a 20 per cent. increase of pay and no increase in output. One of the difficulties met with in timing operations was the deliberate malingering of the men. Of three men timed in this department two worked fairly well. The third, one of the most experienced there, used this experience to increase the number of operations, with the result that he took twice as long as the others, and yet appeared busy the whole time.

In still another department, where the usual output was 8 to 12 pieces per hour, the timing of one of the men's delegates, who volunteered for the purpose, showed that an output of 38 pieces was practicable. The men, however, went on strike to resist the introduction of improved methods. They telegraphed for a reporter to be sent down from one of the London dailies, who was duly informed that the men had speeded-up all that was possible, in spite of which their rate of pay remained stationary. The men said that they had already difficulty in turning out the 8 to 12 pieces per hour which they considered the "recognised quantity." The labour cost on each was, they said, 1s. 3d. per dozen, but in view of the urgency of the work they were prepared to increase their output so as to reduce it to 1s. 2½d. per dozen pieces. The manager, however, on tackling the work himself, turned out 30 pieces per hour, special precautions being taken to avoid the production of defective pieces, even one of which would, of course, have afforded the strikers a weapon of some potency. When, however, his work went into another department, the men there went on strike rather than use the pieces. Overtures were, however, soon made for a settlement. In order to provide the men with an excuse for abandoning their intransigeant attitude, it was decided to rearrange the method of working, and

fresh times were taken. On the basis of these the standard was fixed at 34 pieces per hour in place of the previous 8 and 12. The men were, however, determined to obstruct as much as possible, so that as a compromise the number was reduced to 26½. As confidence was gained that prices were not going to be cut, the men gradually increased this output, so that the average figure rose to between 50 and 76 pieces per hour in place of the original 8 or 12. In spite of the success here, another strike ensued when further improvements were attempted in another department. The men issued an ultimatum, in which they proposed to turn out work at the old rate, but at an increased pay, demanding as a condition of returning to work a written agreement that no further attempt should be made to improve the output or to introduce the bonus system of payment. This was, of course, refused, and the men were ultimately only allowed to return on signing an agreement to do as they were told and to refrain from causing trouble. Enough accepted this condition to allow of work being restarted, and as a result of the improvements made, work is now done by between 20 or 30 men which originally took 80.

The above experience shows very well the unfortunate light in which workmen regard any attempt to introduce methods which will cheapen production. The idea seems to be that the whole of the benefit is reaped by the employer, whereas, workmen being far and away the largest consumers in the country, no class is more affected by high prices than they are. Every improvement which diminishes the cost of shipbuilding, for instance, means in the ultimate a reduction in the cost at which, say, cotton from the United States, wool from New Zealand, or wheat from Canada, finds its way into the workman's home. Similar considerations apply to every department of industry. Indeed, considered as a social unit, the workman may in the long run reap his due share of whatever economies he may personally be responsible for, though as an individual he may suffer from an unfair cut in his piecework rates. Few, however, are content to be treated merely as social units. The idea that in normal times individual effort should reap its individual reward is probably ineradicable by even the most plausible of political theories. These may be acceptable enough when other individuals are to suffer by them, but a personal application is inevitably resented. The ideal for this country to aim at is high earnings and low cost of production. The instances cited by Mr. Rankin show that the two are by no means incompatible, and the Ford car provides another striking example of the truth of this proposition. Its low price is not the result of low wages. It could never have been produced, however, had the workmen employed resented and obstructed every attempt to eliminate wasteful methods of working and to increase efficiency generally.

SOME NOTES ON SHIPBUILDING PRACTICE.

From time to time small changes are made in the practice prevailing in all industries, which, although small, perhaps insignificant, are yet effective, in association with others, in reducing cost and labour and increasing efficiency in the finished product. This applies to shipbuilding practice in a special degree, and yet, because of very casual introduction, these changes are neglected in the literature of the subject. The purpose of these notes is to indicate the present practice in carrying out work in preparing material and in the actual constructional operations on the building berth in the case especially of ships of great size. To those actually responsible for the work the notes may convey little or nothing that is new, but others may be interested, especially as in large establishments the aggregate effect is seldom obvious to workers on details.

In the first place reference may be made to the increasing importance of the work undertaken by the loftsman. The laying down on the mould loft floor and fairing of the outline and form of the vessel, the subsequent transference of the outline of each frame section, beam, lines of keelsons and stringers, centres of propeller shafts, plate edge landings and other usual information to the scrieve board, together with the provision, for the use of the workmen, of battens showing the spacing of frames, expanded moulds for a few plates, and, in the case of armoured ships, the preparation of moulds of the armour plates for the guidance of the steel-makers, was formerly the chief work demanded of the loftsman. He now has to prepare skeleton moulds and sections for all large forgings and castings, such as stems, sternposts, rudders and rudder bearings, shaft brackets, &c., and furnishes the information for the making of such patterns as may be required for any or all of the foregoing items. The modern tendency is all in the direction of preparing for erection, and, where possible, riveting, as much material as possible in the shops. The very great increase in the amount of this "boarded" work, as it is called, has added greatly to the work and responsibility of the loftsman, for he it is who supplies most of the information required by the workman. It is now quite usual to work complete bulkheads, keelsons and side stringers, deck stringers and skin strakes of tank top and deck plating, and even part of the shell plating in the shops. Bulkheads, where small, are sometimes riveted and erected in the ship complete, and where decks are not too large they are sometimes laid down and worked complete for both skin and covering strakes. The procedure is as follows for a deck:—The loftsman draws, on a prepared wooden surface situated in the platers' shed, a full-sized outline of the deck, showing the position of each beam, girder under the deck, deck-house casing bar on top of deck, hatch or other openings, and the positions of all plate butts and edges. If necessary, allowance is made in laying down for expansion due to the sheer of the ship or round up of the beams. The stringer and skin plates are then sheered and planed to the correct size, and laid in their correct position on the boards. The covering strakes are then prepared and the rivet holes in landing edges and butts marked and punched or drilled, after which they are placed in their correct position on the top of the skin strakes. The holes already in the covering strakes are transferred to the skin strakes by means of a marker or centre punch, and the holes for taking deck-house casing angles, gunwale bars, deck girders, hatch coaming angles, &c., marked on the plates. Rivet holes for beams are marked by means of a batten supplied by the loftsman, and, when everything possible has been marked in, the plates are lifted and the rivet holes punched or drilled. With careful workmanship this method gives excellent results, and it ensures the fairness of the ship when finally "screwed up" in position. Time and money are saved owing to the work being done under cover and in close proximity to the necessary machinery.

Concurrently with, and as a direct consequence of, the great increase in the amount of boarded work, there has been a corresponding increase in the amount of material riveted on the ground before erection in the ship. Bulkheads, long lengths of deck girders and side keelsons, small deck-houses, &c., in addition to the usual frames, reverse frames and floors, are now riveted in the shops. Most of this riveting is done by means of hydraulic power, as the machines, being stationary, are most favourably situated for rapid and economical working. The rivets for this class of work are heated in a small oil fuel furnace.

With the increase in size of ships, and the consequent increase in scantling of material and rivets used, it has become of the most vital importance to ensure the maximum strength of the component parts of the ship's structure where such strength is dependent upon rivets and riveted work, and to meet this necessity the use of hydraulic riveting has been developed. Two of the most important items contributing to the longitudinal strength of the ship considered as a girder are the vertical keel plates and sheerstrake, the former being situated at the farthest point below, and the latter at the greatest height above, the neutral axis. Both items by their form lend themselves to the easy and economical application of hydraulic power in riveting, and as a consequence this type of riveting is now largely employed on the items mentioned where exceptional strength is required. Deck plating has in some cases been riveted by hydraulic power, but this is uncommon and costly. The construction of hydraulic riveting machines is such that they cannot be extensively employed on board ship, while their weight and lack of ready portability further discourages their use on the building berth.

Within recent times there has been a very marked increase in the use of the pneumatic hammer for riveting all classes of work, with most satisfactory results, and it is safe to say that this form of riveting will gradually supersede hand riveting and even hydraulic riveting, except in the heaviest class of work. One very important advantage of pneumatic as compared with hand riveting lies in the fact that for ordinary working the squads consist of three and four men respectively, and at the present time especially this saving in man-power is of the very highest importance. Pneumatic power is now also the chief agent in caulking, chipping and drilling operations, and the extended use of the pneumatic drilling machine has done much to speed up the work of riveting, &c., on the building berth as well as to assist in the attainment of greater accuracy by enabling awkward holes to be rapidly and economically bored instead of punched or drilled by hand-power as formerly. For large cutting operations—especially where the cut is of an irregular shape—the oxy-acetylene flame has now very largely taken the place of punching or cutting by hand or pneumatic power, and manholes, lightening holes, cutting ends and flanges of angle and other rolled sections, also armour plates, &c., are now commonly cut by this process.

Important developments have recently taken place in the matter of equipment for the rapid handling of material during its progress through the various stages from the time of delivery in the yard to erection in the ship. In a modern yard the raw material is transported from the steel checker's racks to the platers' shed by means of locomotive or overhead electric cranes. In the platers' shed it is transported by means of overhead electric cranes, and during the operations at each machine it is lifted and held in position by means of an electric or hydraulic crane. When completed and ready for erection in the ship it is loaded on a narrow-gauge railway bogie and wheeled to the building berth, where it is lifted into position by means of overhead travelling cranes or by electric or hydraulic hoisting derricks. Practically at no stage is a heavy plate or bar man-handled under modern conditions.

The welding of plates and angles which do not contribute directly to the strength of the vessel, also a very large proportion of ventilation trunks and other sheet-iron work, welding of flanges on pipes, and many other jobs of a similar nature are now done by means of the oxy-acetylene welding process instead of the older methods.

The improvements made in the methods of working and handling the steel items which go to make up the ship structure have had their counterpart in the internal fittings and decorations. Bulkhead panels, door and ceiling panels are now commonly made of three-ply wood. This wood is made by glueing together under pressure three or four thin sheets of wood so arranged that the grain of alternate layers runs in opposite directions. Wood so prepared is light and strong and does not twist to any appreciable extent. Mouldings and decorations on panels, ceilings and pillars are now cast in stucco or other similar material instead of being worked in wood as formerly. For the floors of cabins, passages, and public rooms and all spaces not exposed to the weather there are now several substitutes for laid wood decks. All these are applied to the steel deck in a fluid or semi-fluid condition and are worked in much the same way as ordinary cement. Of deck compositions perhaps the most satisfactory are those of which the base is mineral pitch and which are applied and worked while hot. For the floors of vestibules and passages india-rubber tiles cemented on top of the deck composition are now much used. In bathrooms, &c., mosaic effects are got by laying a composition containing marble chips on top of a layer of cement and polishing the top surface.

These notes indicate in a very general way some of the more recent developments in merchant shipbuilding practice. The developments and achievements in regard to the building and equipment of warships of all classes during the past two years form a truly remarkable and creditable record, but consideration of and comment on these must be deferred till the end of the war.

ALKALI WORKS IN 1915.

The 52nd annual report on Alkali Works, presented by the Chief Inspector, Mr. W. S. Curphey, to the Local Government Board and to the Secretary for Scotland, runs on familiar lines, and the references to war conditions are general, as was to be expected. Alkali works proper have decreased in number, from 70 in 1913 to 63 in 1915; but other scheduled and registered works have increased from 1,257 to 1,309. There has been diminished output in some works; enormously enhanced activity and extensions of plant in many others, in spite of dearth of skilled hands and scarcity of materials. As a result, improved methods under trial progressed little, repairs not absolutely urgent were postponed, and the forbearance of the inspectors has more than usually been strained. No proceedings were taken for contravention of the Act—in fact, we hardly remember any legal proceedings during recent years—and in two cases, where registrable operations were carried on in unregistered works, back fees were accepted in lieu of suing for penalties.

Pollution of the atmosphere by fumes and dust has, on the whole, been kept within limits. High chimney escapes occurred in one works where nitre cake is used for the production of salt cake and muriatic acid. The nitre cake occasionally contained some undecomposed sodium nitrate; this, when furnaced with salt, gave some chlorine which passed uncondensed into the chimney. An attempted cure by means of sulphurous acid failed because this gas, from the spent oxide burners, introduced much dust; but by directly burning a small amount of brimstone (most of which would itself be converted into condensable sulphuric acid) the chlorine was converted into condensable muriatic acid. Trouble from sulphurous fumes is common in zinc sulphide smelters. Oxidation of the fumes to sulphuric acid is mostly advisable and profitable, but manufacturers hesitate to incur the initial expense, though the report states that one Continental firm was last year gaining 1,000 tons of sulphuric acid per month by this method. In dust prevention in smelters very little has been achieved; one firm, however, was installing electrical plant for dust precipitation on American lines.

In sulphuric acid works on the chamber system the use of mechanical washers for the recovery of nitrous gases leaving the last chamber is slowly replacing the large absorbing towers which, especially when packed with coke, are liable to become inefficient, to the detriment of the whole plant in a few years. Coke is by far the most common packing material for Glover towers, bricks and glass being not much used; in Gay-Lussac towers bricks and flints strongly predominate over rings and tiles. Two fatal cases of gas poisoning occurred while a tank railway wagon and a tank for storing acid were being cleaned. There is always that danger when coke or sludge which has been in contact with strong nitrous vitriol is washed with water previous to removal, and a material that will absorb nitrogen oxide fumes is not known yet, Mr. Curphey points out. In view of these repeated accidents, Mr. Curphey has again drawn the attention of manufacturers to a circular letter of 20 years ago, in which it was urged that towers should be washed with strong sulphuric acid (before applying water and steam), that there should be a downward draught, and that the men should be supplied with a safety-pipe, 50 ft. long, to be able to breathe air from the outside. Sulphuric acid works on the contact system and plants for the concentration and distillation of the acid have been driven to their utmost capacity, and much trouble has been caused by the repeated installation of plants known to be faulty in design and construction, chiefly in connection with the cascade system; the Gaillard towers have also given trouble: the Kessler system has answered best, but the necessary materials for its use were lacking, and the type is not suitable, apparently, for the reconcentration of some kinds of impure acid. Some information is given in the report on the use of basins of silica, ironac, narki and tantiron for cascade plants, which have their advantages when provided with efficient draught and adequate means of condensation, and when excessive heating is avoided.

While chemical manure works have now been decreasing for six years, the number of works making ammonium salts (sulphate and muriate) and of gas liquor works again increased last year, chiefly owing to new registration, however. The total ammonium recovered in the kingdom within the years 1913, 1914, 1915, was 432,618, 426,412, 426,327 tons (expressed in terms of sulphate), the decreases in gas, iron and shale works outbalancing the increased production in coke-oven works. In the latter and in gas works the "direct" method for ammonium sulphate production is extending as it deserves. In the direct process the scrubbers fed with water are omitted and replaced by acid "arresters" or "bubblers," in which the crude coal gas meets with more than the amount of dilute sulphuric acid necessary to bind the ammonia. The direct method has worked smoothly in some works and apparently interfered with the purifiers in others, and the yield of ammonium has mostly been below the average of the old process. Dr. A. C. Fryer (one of the inspectors) has further investigated this problem. Iron oxide purifiers, it was known, should contain a little ammonia and not be neutral or acid, and it was assumed that the "direct" method recovered all the ammonia from the gas entering the purifier. Dr. Fryer finds, in conjunction with Dr. Harold G. Colman, that there is always sufficient ammonia left in the gas, and there is no need for providing a special by-pass or some means of feeding ammonia into the purifier; this provision is, indeed, he finds, the chief source of the poor ammonia recovery. A careful study of the complex reaction leads him to the conclusion that the purifier boxes should be under roof (not exposed to the cold and rain in the open), that their moisture content should be regulated, and the crude gas entering the purifier should be dry and cool. Further works tests are required; but most of the losses certainly seem to be avoidable. "Souring" of the oxide purifiers is chiefly experienced in Scotland, where the temperature is low. Stored ammoniacal liquor should be covered with a film of oil (0.1–0.25 in. thick) to prevent escape of ammonia; that was recommended in 1914, and has fully answered; the tar oil itself prevents escape. The hydrocyanic acid should be absorbed before the gas passes into the arrester. While recommending improvements, Mr. Curphey cautions managers against abruptly introducing too many radical changes at the same time.

The pressure on nitric acid works was very hard too, of course. The ordinary decomposition of sodium nitrate by sulphuric acid did not create any nuisance, but some works for the recovery of nitrous fumes gave rise to serious complaints; the general position was already improving, however; a synthetic nitric acid process was not used in any works under inspection. As regards tin-plate flux works, much remains to be done with respect to condensation of noxious fumes, and Dr. Lewis Bailey has still to complain that those interested are so little inclined to investigate the scruff problem in spite of their own heavy losses through defective furnacing and deposition. Mr. Curphey charged Dr. Bailey and his own assistant, Mr. E. Linder, with experimenting in works where furnace conditions were favourable and the managers ready to assist; this investigation had to be discontinued in April, 1915. The results so far obtained quite confirm Dr. Bailey's previous recommendations—low working temperature in the furnace, large-area condensing flues with sumps and baffles, regulation of draught at the chimney end of the flue (not at the furnace), and reduction of the temperature of the gases by bringing them in contact with water at an early point in the flue. These experiments, like those of Dr. Fryer previously mentioned, are described at length in the report.

The picric acid works increased from 8 to 13, those in existence were enlarged, and what we said about pollution of the acid by nitrous fumes holds for these works as well. Tar works increased from 205 (in 1914) to 248. The plant chiefly adopted is the dehydrator type, which yields tar for road maintenance and light tar oils elsewhere to be treated for benzene and toluene; there is no excuse, hence, for the use of crude tar on roads. Operations in tar works were irregular. As regards production in the United Kingdom the following statistics are offered with reserve: Tar distilled in gas works, 1,311,383 tons; in other works, 163,927 tons; pitch produced in gas works, 669,489 tons; other works, 80,307 tons.

The use of mechanical furnaces, especially in connection with the extraction of copper by the wet process, is progressing. The number of zinc extraction works remained at 12, as in 1914 (13 in 1913), but several plants were considerably extended. No progress is reported regarding the treatment of fumes from zinc furnaces and zinc blende calcining furnaces already referred to. Dr. Fryer expresses surprise that zinc smelting has not grown on a much larger scale, considering that zinc ores from Australia are now abundant, and also that John Campion started zinc distillation—practised in China and India long before that—at Bristol in 1739, and that this smelting was introduced from England into Silesia and Belgium about 1800.

The report of the inspector for Scotland, Mr. J. W. Young, does not call for special notice. He had to record two accidents, unfortunately; in the one the foreman was the victim and owed his illness to direct disregard of the regulations; in the other a man had inadvertently stopped the ventilating pipe and was choked in spite of the brave efforts of his fellows, whose courage received the generous appreciation of the Carnegie trustees. Under the Act of 1906 the United Kingdom and Ireland are divided into 10 districts numbered I to VII, with IIIa, IVa, VIa as special districts, the inspectors and sub-inspectors being Messrs. T. L. Bailey, E. Moseley Fletcher, Herbert Porter, H. J. Bailey, R. D. Littlefield, A. C. Fryer, A. C. Carter (in the army), F. Wagner Sutton, and J. W. Young. One of the English inspectors, Mr. Edward Jackson, died in April, 1916. Mr. Curphey regretted to have to add this news to his report, which he concludes by drawing attention to the formation in France of a limited liability company for the manufacture and sale of sulphuric acid, and for all scientific and technical researches, and all industrial, commercial and financial operations concerned with this object.

NOTES.

Thermalene, a Substitute for Acetylene.

The thermalene gas of Mr. K. F. Wolf, of Zürich, Switzerland, which is recommended as a substitute for acetylene, especially for welding, is described as an acetylene which, in its generation, is impregnated with oil gas and thereby rendered less explosive than acetylene and more suitable for lighting. Thermalene is generated in closed tin cases or cartridges which are charged with alternating layers of calcium carbide and of sawdust; the latter is soaked in oil; the kind of oil used is not specified in the *American Machinist* of September 2, 1916, from which we quote. When water penetrates into a cartridge from below—the cartridge having been pushed into the generator—acetylene is liberated with the evolution of heat, the oil is heated, and the acetylene becomes impregnated with oil gas as it forces its way through the sawdust. As the resulting lime expands considerably, and as oil and carbide must not come in direct contact with one another, the layers of carbide and of oil are separated by two discs of cardboard, between which spacers (metal spirals) are interposed. The lime and impurities in the carbide remain in the cartridge and are ejected with it; it is also claimed that the carbide in a cartridge need not all be decomposed at the same time. The cartridges, 8 in. high, 4¾ in. diameter, weigh 6 lb. each. The largest cartridges weigh 40 lb. The resulting thermalene gas is described as heavier than air, density 1.1, and as less explosive than acetylene; liquefied thermalene is not explosive at all. The gas requires less oxygen than acetylene for burning, and its specific heat is only one-eighth of that of acetylene; mixing better with oxygen, it is said to give a better flame and not to absorb carbon from the iron in welding, so that a soft weld is obtained, especially with cast iron. Thermalene is also credited with having a sweet, not unpleasant smell, and with not being poisonous. A portable welding outfit consists

of generator, gas storage tank and oxygen cylinder. The weld is made with the aid of a torch, which is specially designed against flashing back. The thermalene pipe and the oxygen pipe are screwed into the mixing chamber or body of the torch, which is provided with several screens; the thermalene passes directly into the chamber, the oxygen enters a nozzle, which goes through the chamber and screens and terminates at the far end of the chamber, where it narrows into the long torch nozzle. Should the flame flash back, therefore, it would not burn in the chamber, which otherwise might be fused. Special tips to be screwed to the torch are provided with the nozzle in 12 sizes.

Increased Activity in Merchant Shipbuilding.

There is a steady improvement in the volume of merchant ships being turned out in this country with the approval of the Admiralty, the launches during the past three months being greater than since the early months of the war. Thus 86 vessels of a collective gross tonnage of 192,267 tons were floated, as compared with 91 vessels of 157,594 tons in the preceding quarter, 69 vessels of 81,661 tons in the first quarter of the year, and 72 vessels of 94,056 tons in the last quarter of 1915. The feature, however, of greatest significance is the number of vessels on which building operations have been commenced. These number 96 for the quarter just concluded, and make up 320,120 tons gross. This compares with 84 vessels of 193,719 tons in the preceding quarter. For an equally large volume of work commenced it is necessary to go back to the concluding quarter of 1914, when the absorption of shipbuilding yards for Government work first became operative in checking the ordering of merchant ships. As a consequence of this large accession to the work on hand, the total number of merchant vessels under construction, taking into account only vessels of 100 tons and upwards, was at the end of September, according to Lloyd's quarterly return just issued, 469, of a total gross tonnage of 1,789,054 tons. This is the largest volume of merchant work on hand at any time since the end of 1913, from which date there was a steady diminution of work on hand. The total is about 249,000 tons more than in June of this year. and 253,000 tons more than in September of 1915. This is, from many points of view, a highly satisfactory result; it is of some significance, too, but on this latter point the figures must be left to speak for themselves. Every district in the kingdom has shared in the new work given out. Perhaps the Tyne has profited most, as here the increase in the work on hand during the past three months was from 67 vessels of 310,577 tons to 77 vessels of 401,926 tons, equal to 91,349 tons. In the Greenock district there are five more vessels building, equal to 46,450 additional tons, the work on hand now including 57 vessels of 285,280 tons. The Tees shows an increased tonnage on hand of 24,810 tons, the 27 vessels in course of construction now having an aggregate of 76,480 tons. Sunderland has also shared well, the four additional ships representing an increase of 22,645 tons, since the 56 vessels on the stocks represent 220,004 tons. At Hartlepool there is one additional vessel, the 13 making 72,275 tons, an increase of 2,650 tons. At Belfast there are now building 26 vessels of 281,250 tons, an addition of two vessels and of 19,150 tons on the work on hand three months ago. At Glasgow the increase is three vessels of 23,314 tons, the vessels on the order books numbering 70 and measuring 319,332 tons. At Hull, 58 vessels of 39,452 tons are under way, and at Liverpool 12 vessels of 26,494 tons.

Proposed Penalties for Uneconomical Use of Coal.

Although the State acts on the principle that the members of the community may be sometimes compelled, under threat of penalties, to do that which is best for themselves, it must be accepted that a bold step has been taken in the mere suggestion of a penalty upon users of coal who consume it in an uneconomical manner. And yet this is the conclusion arrived at, obviously in all sincerity, by Mr. R. A. Chattock, M.I.E.E., city electrical engineer and manager of the Birmingham Corporation Electric Supply Department. The proposal was made in his presidential address delivered last Saturday to the Birmingham Association of Mechanical Engineers. In this the principal topic discussed was the achievement of a higher degree of efficiency in all manufactures. Mr. Chattock was undoubtedly influenced by the important contributions made to the British Association at its Newcastle meeting and fully recorded in Engineering. He hopes for much quicker advancement in fuel economy as a result of the work of the special committee of the Association, particularly towards the higher economy in the use of coal by gasifying it and recovering its valuable by-products. This, he pointed out, is impossible for individual manufacturers, since the degree of economy is largely dependent on the extent of the operation and the fullest utilisation of handling and other apparatus, requiring, as it must necessarily do, a great capital charge. He looks forward therefore to the installation of plants as near to the great coal centres as possible, having due regard to a sufficient supply of water for condensing purposes. This latter is an important consideration, since, if cooling towers are used, he estimates that 3,000,000 gallons of water per day would be required to be evaporated per 100,000 kw. of plant installed, so that a station of 800,000 kw. would evaporate the equivalent of all the water continuously flowing into Birmingham from the city's great Welsh reservoirs. Schemes of a less ambitious character are in progress, as has already been recorded, and no doubt these will yield some measure of guidance for the future. No one questions the view that the power generated at such stations must be transmitted electrically, and in such form it can, in Mr. Chattock's view, be utilised for all the purposes for which coal is now used. There is further advantage in the institution of large power stations by reason of the economy of large units and the equalisation of the load factor. Mr. Chattock anticipates power stations of 500,000 kw. capacity using in part coal otherwise unprofitable to work or transport to cities throughout the kingdom. By this means he thinks there would be enormous gain (1) by the proper conservation of the coal supply of the country; (2) by the elimination of smoke from our atmosphere; (3) by the possibility of giving a supply of power to manufacturers and other users at a figure so low that it would represent a saving in their cost of production, and consequently a most valuable asset to the commercial prosperity of the country and a weapon to fight foreign competition; and (4) by relieving the congestion on the railways owing to the reduced traffic of coal, which at present has to be delivered all over the country, and under this scheme would only have to be delivered by special lines to certain fixed centres. He seems disheartened, however, by the slow development of the electric supply business in the past, and stated that it would appear that some form of compulsion should be exercised, in order to increase the rate of development. This compulsion he proposed should be exercised directly by the Government control of the coal supply of the country, or indirectly by putting a tax upon users of coal who consume it in an uneconomical manner. Such a tax, he concluded, should be utilised for financing schemes for exceptionally large power stations, gasifying the coal and recovering its valuable by-products, or utilising the small coal, until such power stations became self-supporting.

Our Pig Exports.—The exports of pig and puddled iron from the United Kingdom in August were 95,925 tons, as compared with 73,450 tons in August, 1915, and 28,401 tons in August, 1914. In these totals pig of all kinds figured for 95,655 tons, 73,283 tons and 28,342 tons respectively. The aggregate exports for the first eight months of this year were 675,221 tons, as compared with 319,721 tons in the corresponding period of 1915, and 615,297 tons in the corresponding period of 1914. In these totals pig of all kinds figures for 673,998 tons, 318,575 tons and 614,339 tons respectively. The largest exports of pig iron to any one country have been made this year to France which took 390,584 tons to August 31, as compared with 45,571 tons in the first eight months of 1915 and 86,622 tons in the first eight months of 1914. The great increase in the French demand is, no doubt, explained by the occupation of the Northern French metallurgical districts by German troops. Italy also imported 91,276 tons of British pig to August 31 this year, as compared with 47,610 tons in the corresponding period of 1915 and 64,672 tons in the corresponding period of 1914, while the United States took 56,647 tons to August 31, as compared with 42,354 tons and 57,689 tons.

LITERATURE.

Industrial Gases, including the Liquefaction of Gases and the Manufacture of Hydrogen, Oxygen, Nitrogen, Carbon Dioxide, Sulphur Dioxide, Ammonia, Producer Gas, Illuminating Gas, Acetylene, Ozone, &c. By Geoffrey Martin, D.Sc., Ernest A. Dancaster, B.Sc., J. M. Dickson, B.Sc., Frank B. Gatehouse, F.C.S., E. Jobling, B.Sc. and H. Stanley Redgrove, B.Sc., F.C.S. London: Crosby Lockwood and Son. 1916. [Price, 7s. 6d. net.]

The important part played by chemical industries in maintaining national welfare and pre-eminence is now vigorously insisted upon, and the indifference with which those responsible for the nation's advance have treated these in the past is generally regarded as a calamity. In a spirit of contrition, some desire has been shown to remove the effects of past neglect, and various schemes have been suggested, framed with the view of creating a greater interest in scientific work, its achievements and its possibilities. The issue of such a series of Manuals on Chemical Technology as that edited by Dr. Geoffrey Martin, and of which the above-quoted work is a recent specimen, might very well have been utilised to promote this end, for the various authors deal with subjects well fitted to compel curiosity and to stimulate enthusiasm. But such a purpose has not appealed to the authors. They address themselves rather to chemical engineers and technical experts, who need an index to patent literature and to that vast storehouse of information that lies hidden in the transactions of learned societies. For these the authors have catered liberally. Without going so far as to say that the references to the many patents on these wide-reaching subjects are complete, it is probably correct to say that no important patent has been overlooked and no source of information neglected. Consequently, though the student or the amateur may not find the details of processes set out with the fullness he might wish, he is enabled to consult original memoirs in which these are discussed. On the other hand, some of the information provided may seem rather trite and elementary to the expert, who may think the references to Martin's "Industrial and Manufacturing Chemistry" too frequent and unnecessary. In such a paragraph as the following (p. 96): "The nitrogen can be obtained from the atmosphere, either by liquefying it and fractionally distilling it with a Linde or Claude machine, as described in Martin's 'Industrial Chemistry,' Vol. II, or simply by passing air over heated copper. The hydrogen can be obtained industrially by any of the methods discussed in 'Martin's Industrial Chemistry,' Vol. II," the information is neither exhaustive nor satisfactory, while two references, within three lines, to another work by the author become a little irritating.

The opening chapter by Mr. Dickson treats of the liquefaction of gases and contains a very readable account of the two main processes now employed, viz., that perfected by Linde, in which liquefaction is attained without external work, the Thomson-Joule effect being sufficient to produce the necessary lowering of temperature, and that by Claude, in whose solution of the problem is utilised a suggestion by Lord Rayleigh, that the air on expansion should drive a turbine which would have the result of increasing the cooling effect and of recovering some of the power employed. Of more importance in the economical working of the apparatus is the plan of admitting the compressed gas to the expander at a temperature as high as is consistent with the attainment of a final temperature below the critical. The most recent improvement towards this end consists in effecting the expansion in two stages. The expanded gas has its temperature raised by being made to circulate about coils filled with air above its critical pressure.

Industrially, the process of liquefaction is important in providing a means for separating the constituent elements of air, a problem essentially similar to that of the separation of alcohol and water when mixed together, advantage being taken of the difference in volatility of the constituents. The simple fractional evaporation of liquid air, however, gives poor results, and the merit of commercial improvement belongs to Linde, who devised a suitable method of rectification. It is now possible to produce, at a very small cost, large quantities of oxygen, 99 per cent. purity, and of nitrogen an even

higher degree of purity is attained, in order to meet the demand of the industries fixing atmospheric nitrogen. In 1908 a 200-h.p. electric motor was producing 3,000 cub. ft. of nitrogen per hour, but with larger plant now erected at Odda (Norway) these figures have long been passed. In all modern plants the lowered temperature is used regeneratively, and it is now found possible to pass air at ordinary temperature into an apparatus, from which oxygen and nitrogen issue at only a slight difference of temperature. The contemplation of the possibilities of the future, consequent on the attainment of a cheap and ready supply of oxygen, is most fascinating. The furnace of the future will burn coal in oxygen rather than in air, thus saving the heating of a mass of useless nitrogen, and this will find application in other directions. Industrial chemistry in its many applications has always had to contend against the disadvantage of using oxygen diluted with five times its volume of nitrogen a revolution in many technical processes may be anticipated when this handicap is removed.

Dr. Martin gives a table showing the amount of oxygen supplied by the Linde plants alone in various countries in 1911. Germany was easily first, utilising 6,000,000 cub. m., America second, but a long way behind, with 2,676,000, and England third, with 2,230,000 cub. m. There is no reason to think that the relative proportions have much varied.

Only a page is devoted to the manufacture and properties of industrial nitrogen, but Mr. Redgrove is more liberal in his treatment of hydrogen, a gas that has acquired industrial importance by reason of its many applications. The Linde–Frank–Caro process might well have been more elaborated, as a method largely used for obtaining a tolerably pure hydrogen that finds ready use in such industries as the hydrogenation of fats and synthetic ammonia, to say nothing of the demands of aeronauts, who find it indispensable in the employment of airships of the Zeppelin and dirigible class. The cost of production, about 97 per cent. pure, is said to be 1½*d.* per cub. m. "Hydrolith," a calcium hydride prepared by a Jaubert patent, is a more expensive form of production, but much used in military ballooning, owing to its convenience. No cylinders for storage are needed, and the saving in transport is considerable. One kilogram is said to yield a cub. m. of hydrogen, and the evolved gas is given off with such rapidity that an average-sized dirigible can be filled in about four hours.

The same contributor gives a good paper on producer gas, its method of manufacture, and its advantages as a fuel. We may admit all that he urges in its favour and concede the apparent advantage of turning to account fuels that are too poor in quality to be worth utilising otherwise. But gas-fired boilers have proved of very variable efficiency, and the results cannot always be explained by the condition of the apparatus and the degree of attention given by the workmen. The high results attained by the Bone and M'Court method, here referred to, are not yet general. There are probably difficulties in ensuring complete combustion, and possibly the character of the refractory material used in the furnace influences the result. But in some forms of application trouble is traceable to the form of solid fuel employed, and with greater variety, greater uncertainty in efficiency may be anticipated.

After a short description of the carbon-dioxide industry, and a page on the manufacture of nitrous oxide by the Editor, the large subject of ammonia is introduced, and its importance is shown by the fact that Dr. Martin devotes some 20 pages to its consideration, a portion of which is claimed by the fascinating problems connected with synthetic ammonia. Yet great as the subject is, and informing as are the statistics quoted, we doubt if the unprepared reader would grasp adequately what is being accomplished in this particular field of applied science, and the revolution the preliminary successes presage. Those who are acquainted with the Birkeland–Eyde, Schonherr's or Pauling's process for the direct oxidation of nitrogen by means of an electrical discharge, or with Frank–Caro's method of forming cyanimide from carbides, will be glad to have a resumé of the important literature and opportunity for considering the main patents. The Serpek process for the production of ammonia from aluminium nitrides, combined with the utilization of alumina, is likely to have a great future, since the electric energy required is about eight times less than that required in the Birkeland–Eyde process and one-half less than that of the cyanimide process, but possibly this method has already been superseded by new schemes, hidden from us by the smoke from many battlefields. But if ammonium salts, whether recovered from the by-products of gas-works, or on a larger scale by some of the chemical processes that yield nitrogen fertilisers, are to be regarded as important at all times for providing manures and fighting the spectre of nitrogen starvation, these processes, or at least some of them, are at the present moment of profound interest in the manufacture of explosives. This is an outlook that Dr. Martin does not make impressive, and we think he misses a great opportunity for enlisting the intelligent interest of a curious public.

Calcium carbide plays a more peaceful but hardly less captivating part, as Mr. Gatehouse reminds us, in the production of acetylene, so largely used as an illuminant for the lighting of private houses, street lighting, light-ships, &c., wherever an intensely concentrated light is needed. In engineering circles it is well known for its use in autogenous welding and also for the cutting and welding of metals. Mr. Gatehouse reproduces a sensational picture of an oxyacetylene flame cutting armour plate 9 in. thick, but we believe the cunning metallurgist has found an alloyed steel which defies the oxyacetylene flame and refuses to be either drilled or exploded. The use of such steel in industry must be limited, but such successful manufactures illustrate the ingenuity of the chemist and the choice of materials with which he can operate.

The penultimate chapter is by Mr. Dancaster on illuminating gas, covering rather familiar ground, and the book closes with an informing chapter on ozone by Mr. Jobling. The number of systems at work for the manufacture of triatomic oxygen shows that there is a large demand for ozone, mainly as a destructive agent of pathological micro-organisms and for water sterilisation, but its superiority over older systems does not seem to be completely demonstrated. The general method for the production of ozone consists in passing dry air through an apparatus in which it can be submitted to the influence of a silent high-tension electric discharge. The production of oxides of nitrogen from the burning of atmospheric nitrogen is a disadvantage that is sought to be eliminated in various ways, and gives rise to some complexity in the apparatus. The method of use is as important as the production. That ozone is a potent deodorizer must be admitted, but it is doubtful whether objectionable smells are destroyed by its presence or are only masked by its use. In tube railways, such as the Great Central, the effect is apparently beneficial, presumably by freshening the atmosphere and relieving the stale quality of the air, but the precise method in which ozone operates, when only one part in a million is present in vitiated air, is doubtful. The use of ozone in the sterilisation of potable water appears to be on the increase, but for efficacy it is necessary to secure contact between the injected ozone and the matter it is intended to destroy or neutralise.

A Text-Book of Practical Physics. By H. S. Allen, M.A., D.Sc., and H. Moore, A.R.C.Sc., B.Sc. Macmillan and Co., Limited. London: 1916. [Price, 8*s.* 6*d.* net.]

This is one of those manuals that are the natural outcome of teaching, the training of large classes, and the effort to produce effective results with the smallest expenditure of teaching power. The ground covered is approximately that of Déschanel, that is to say, the treatise provides an adequate introduction to the study of mechanics, acoustics, light, heat, magnetism, and electricity. The information provided is designed to cover the needs of candidates for junior appointments under the Civil Service Commission, and to satisfy the requirements of examiners in the Intermediate Pass courses in science, engineering, and medicine, as well as for University Scholarships. A feature is made of selected experiments intended for those students from whom a practical course in applied mathematics is demanded, and these experiments seem to be selected with judgment and carefully graduated. They should suggest to the intelligent student methods of practical work, allied in character, but to which it is not possible to refer in the text. This remark refers more particularly to the electrical section, and it is refreshing to note the increase in the quantity of practical and experimental work demanded from the student. Without encouragement in the use and handling of apparatus, progress is one-sided and the purposes of education stultified.

Every teacher has his own plan of teaching physics, experience having inclined him to attach importance to particular detail as necessary for a clear grasp of the subject. There is no necessity to urge a close imitation of the methods that the authors have explained here, but many teachers would benefit from a study of the logical and definite arrangement, well adapted to the elucidation of physical principles. The book is well illustrated and indexed. The logarithms and physical tables given in an appendix might have been extended with advantage.

BOOKS RECEIVED.

United States Geological Survey: Bulletins. No. 620–B: *Nitrate Deposits in Southern Idaho and Eastern Oregon.* By G. R. Mansfield. No. 620–C: *Gold Deposits near Quartzsite, Arizona.* By Edward L. Jones, Jr. No. 620–D: *Some Cinnabar Deposits in Western Nevada.* By Adolph Knopf. No. 620–E: *Iron Ore in Cass, Marion, Morris and Cherokee Counties, Texas.* By Ernest F. Burchard. No. 620–F: *Quicksilver Deposits of the Mazatal Range, Arizona.* By F. L. Ransome. No. 620–G: *Iron-Bearing Deposits in Bossier, Caddo and Webster Parishes, Louisiana.* By Ernest F. Burchard. No. 620–H: *A Reconnaissance in the Kofa Mountains, Arizona.* By Edward L. Jones, Jr. No. 620–J: *Potash in Certain Copper and Gold Ores.* Compiled by B. S. Butler. *With a Note on Muscovite.* By George Steiger. No. 621–A: *Field Apparatus for Determining Ash in Coal.* By C. E. Lesher. No. 621–B: *The Healdton Oil Field, Carter County, Oklahoma.* By C. H. Wegemann and K. C. Heald. No. 621–C: *The Loco Gas Field, Stephens and Jefferson Counties, Oklahoma.* By Carroll H. Wegemann. No. 621–D: *The Duncan Gas Field, Stephens County, Oklahoma.* By Carroll H. Wegemann. No. 621–G: *The Lawton Oil and Gas Field, Oklahoma.* By Carroll H. Wegemann and Ralph W. Howell. No. 621–H: *Anticlines in the Clinton Sand near Frooster, Wayne County, Ohio.* By C. A. Bonine. No. 621–I: *The Orofino Coal Field, Clearwater, Lewis and Idaho Counties, Idaho.* By Charles T. Lupton. No. 621–J: *A Reconnaissance for Oil near Quanah, Hardeman County, Texas.* By Carroll H. Wegemann. Washington: Government Printing Office.

English and American Tool Builders. By Joseph Wickham Roe. New Haven: Yale University Press; London: Humphrey Milford, Oxford University Press. [Price 12*s.* 6*d.* net.]

Atti del Collegio degli Ingegneri Navali e Meccanici in Italia, 1915. Genova: Tip.-Litografia del Commercio, Alberto Vaccarezza and C.

The Railway Library, 1915. *A Collection of Addresses and Papers on Railway Subjects: Also Statistics for the Year Named.* Compiled by Slason Thompson. Chicago: Bureau of Railway News and Statistics, 1529 Railway Exchange Building. [Price 1 dol.].

Practical Mathematics for Technical Students. Part II. By T. S. Usherwood and C. J. A. Trimble. London: Macmillan and Co., Limited. [Price 7*s.* 6*d.*]

Earth Pressure, Retaining Walls and Bins. By William Cain. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 10*s.* 6*d.* net.]

University of Illinois. Bulletin No. 87: *Correction of Echoes and Reverberation in the Auditorium, University of Illinois.* By F. R. Watson and James H. White. Urbana, Illinois, U.S.A.: University of Illinois; London: Chapman and Hall, Limited. [Price 15 cents.]

Memorandum on the Industrial Situation after the War: The Garton Foundation, Privately Circulated among Employers, Representatives of Labour, and Public Men of all Parties, May–September, 1916. Now published as revised in the light of criticisms and suggestions received. London: Harrison and Sons, St. Martin's-lane. [Price 1*s.* net.]

Hille' Polish-English and English-Polish Vest Pocket Dictionary, with Conversations and Idioms. By Francis Bauer Czarnomski. London: Leopold B. Hill. [Price 1*s.* net.]

Canadian Items.—The value of the forest products exported from Canada during the year ended July, 1916, was 54,642,375 dols. The province of Quebec produced asbestos in 1915 to the value of 3,554,000 dols., and copper ore to the value of 1,021,000 dols. The potential water force of Canada is estimated at 17,000,000 h.p.; the province of Quebec figures in this imposing aggregate for 600,000 h.p.

ACCIDENT TO THE NEW QUEBEC BRIDGE.

In our issue of September 15 we announced the accident which befell the suspended span of the new Quebec Bridge as it was being lifted from the barges into position. It will be remembered that it had been raised about 30 ft. when it suddenly fell over and dropped into the river, which is very deep. In our article we illustrated and described the means of lifting, and explained that the rocker bearing under one of the ends of the girder failed, and that this failure was the cause of the disaster.

In our issue of September 29 we published three views of the suspended span, first as it appeared when afloat on the barges; second, when nearly in position previous to lifting; and third, in the act of falling.

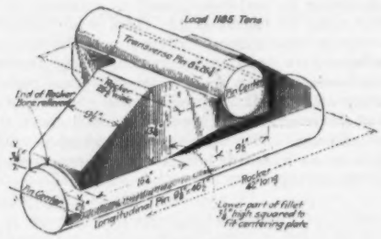

Load 1185 Tons
Transverse Pin 4.434"
End of Rocker Bearing
Rocker 22'-10"
Lower part of fillet ¾" high squared to fit centering plate

Fig. 2.

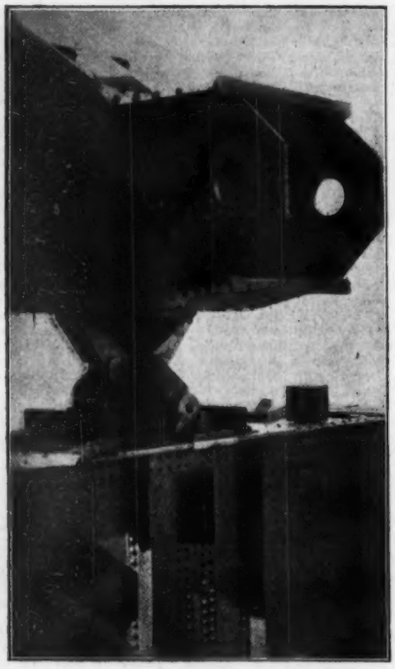


Fig. 3.

The first American technical papers dealing with the accident arrived here on the 5th inst., and in our issue of the 6th we reproduced a part of the descriptions which appeared in the *Railway Age Gazette* and in the *Scientific American*. Later information just arrived seems to negative the theory set forth in the latter paper, which was that the lifting girder was hung on a centre below the support of the load, and was therefore in unstable equilibrium. Fig. 1 above is a reproduction of one of our former engravings to show how the lifting chains were connected to the lifting girders, and this shows that the girder was not held in unstable equilibrium.

The failure took place at the south-west corner, as shown in our illustration of September 29, in one of the rocker bearings. All four bearings are shown in the illustrations we publish on this page, and their positions in regard to the span are marked. There is also (Fig. 2) a view of one of the rocker bearings, while Fig. 3 shows it in place. To keep the castings in proper central bearing when the hangers picked up the lifting girders, four centring plates were bolted to the bottom casting and carefully fitted (in the shop before erection of the span) into the inner corners of the cruciform rocker, and matchmarked. Placing these centring plates was one of the last jobs before the span was towed out. They do not seem, however, to have fulfilled their purpose, and a good deal of the detailed examination of the bearings after the accident which we publish below refers to these plates.

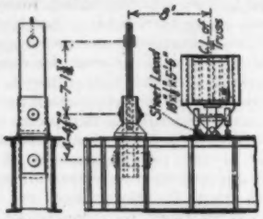


Fig. 1.

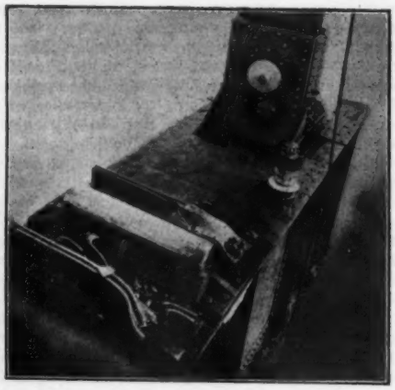


Fig. 4.

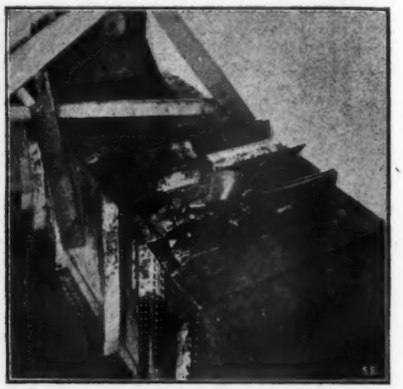


Fig. 5.

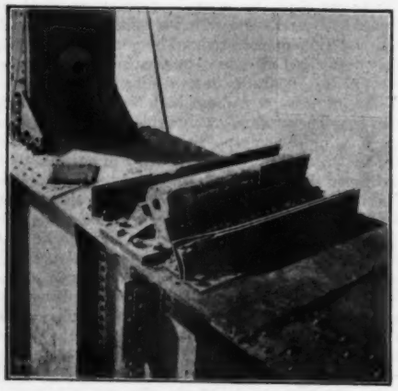


Fig. 6.

Fig. 7.

On the 11th inst, we received a copy of the *Engineering News*, to which we are indebted for the following extracts and illustrations:—

"The officers of the St. Lawrence Company, after giving us every courtesy and aid in connection with our investigation of the unfortunate disaster to the suspended span at Quebec, so that we might have the statement published in *Engineering News* for the information of the profession as accurate as possible, asked us to extend the courtesy to all other technical journals who might desire it of advance proofs of our articles and illustrations, in order that there might be similar accuracy in accounts of the accident in other technical publications. The accident was witnessed and the detailed examination was made by Harry Barker, Associate Editor of *Engineering News*, through the courtesy of the officers of the St. Lawrence Bridge Company, Phelps Johnson, president; G. H. Duggan, chief engineer; G. F. Porter, engineer of construction; and S. P. Mitchell, consulting engineer of erection.

"Descending the south-west hanger, the most prominent thing observed was that, of the four centering plates [Figs. 4 and 8], the north-west plate was in place but crushed down vertically with two bolts sheared off vertically and two intact. Alongside of it was the girder suspension bridle, in place, also crushed vertically. The south-west centering plate was missing, but its bolts had been sheared off vertically, also indicating the descent of some vertical load upon it. Probably both north-west and south-west plates were crushed down by the same action, and their different behaviour is due to incidental effects.

"The presence and condition of these two centering plates really is the key to the whole evidence on this hanger. It proves that there could have been no departure from normal conditions up to the moment some vertical blow was delivered to the west centering plates of the south-west hanger. These plates are the only points on any of the hangers where vertical action is indicated—all else shows a combination of turning, twisting and sliding. The vertical injury to these two plates must have preceded all other effects noted elsewhere.

"The other two centering plates at this hanger showed the bolts sheared downward and forward (i.e., toward the suspended span) at 45 deg.; the south-east centering plate was free and the north-east one was missing. These conditions indicate backward movement of the girder occurring on the east side of the pin simultaneously with the dropping of the truss shoe.

"The lower pin was in place, but rotated eastward on top 1½ in. and scored spirally, indicating backward movement of the girder and crosswise movement of some superimposed burden. The east bridle angles close by showed a deep 45 deg. gash, indicating the same movement as shown by the pin.

"The south tie plates on both the box hangers were found bent by contact against the connecting link of the hanger chain, the easterly one being the more damaged. These bent plates indicate positively a strong rotation of the lifting girder. The inner (east) chain shows a scored edge, which can be explained by the chain's shearing through the bottom end strut between trusses. This end strut consisted of two ribs, each made of a 54 by ⅞ in. plate, and two 6 by 6 by ⅞ in. angles, and the inner chain passed through between the two ribs; before the span could separate from the lifting girder or hanger chain, the inner chains had to tear its way through one rib of the end strut.

"The earliest steps of the accident are made apparent

by the just-described conditions at the south-west hanger. Something must have broken in the north-east quarter of the shoe detail. It could have been only the intermediate or rocker casting [Fig. 2]. The fracture most probably occurred near the root of the front lower pin bracket of this rocker, putting the bearing on the lower pin out of service; and in all likelihood the fracture entered the upper pin seat and one of the upper brackets also.

"Concentration of the enormous 1,200 ton load on the fracture edges must have caused crushing, tipping of what was left of the rocker, and some backward movement of the lower shoe and lifting girder. It was incidental to this quickly-passed stage of the catastrophe that the westerly fragment of the rocker bore down on the two west centring plates, curling one of them over and forcing the other off by downward shear. In the same action, however, the fragments of the broken rocker were ejected from between its two pins like a smooth wet orange seed, and the impulse kicking back the entire swinging girder, the corner of the span fell free, only grazing the pin and the girder cover plate as it went off.

"These events, written in the markings on the south-west girder, make all other actions subsidiary. And, indeed, the examination of the other three girders shows the very actions there that must follow from the starting of the fall as just sketched."

The South-East Hanger.—Some parts of the south-east hanger [Fig. 5] were severely punished, while others escaped very easily. Some 8 feet above the girder top the inner hanger chain was badly bent, forced to the west, and heavily scored. The pressure accompanying the movement at this point is indicated by signs of high local heating of the steel in the score marks on the inner hanger chain.

The pin in the box hanger was moved west 1 in., but showed no signs of rotation. The top inside edge of the west plate of the west box hanger was crushed, and the box rivets were forced into the link. The south bracket at this box hanger was untouched, and the north bracket had its east edge only slightly bent inward. The corresponding detail at the east box hanger is entirely untouched.

Looking at the lower shoe detail it is seen first that all four of the centring plates are in place and bent outward. On both the east plates are found large splashes of pin grease, and the direction of these splashes indicates that some turning of the rocker casting must have neatly spooned the lower pin out of its pocket. The turning of the casting undoubtedly bent down the westerly plates, and the pin forced over the easterly pair. Remarkable to record, the upper pin lies in the lower pin bearing; to drop into this position it must have turned 90 deg. from its original direction. The crushed and beat-in west bridle hitch angles and bridle are further evidence of this action. The bent and scored edge of the girder cover plate near by marks the final path of the edge of the truss end post as it left the lifting girder.

What happened at the south-east hanger is easily understood. The photograph of the falling bridge gives a perfect picture of the action, the same as read out of the conditions of damage. [See ENGINEERING, September 29, page 306.] The overturning west truss, through the action of the portal and top laterals, twisted the end post of the east truss to the westward and down. The bottom end truss, already torn loose from the west truss when that ripped through the hanger chain, offered no resistance to the tipping movement. The truss was tilting on its lower rocker pin at the start, and after reaching the limit of the rocker's turning freedom it canted and slid on the transverse pin, forced the rocker out backward and eastward, and dropped the upper pin, now vertical, into the lower shoe, where it dropped into the bearing. The end post now was on the point of slipping off, having in the meantime banged heavily against the inside face of the west hanger; it dropped to the river, hardly touching the top of the lifting girder. The blow from the end post, possibly supplemented by downward pressure from the end strut, tilted the whole girder series of the hanger about the longitudinal supporting pin on the top of the upper chord of the cantilever arm. But there was no rotation about an east-west axis; the east truss tipped purely westward, remaining a span between its two end bearings until the moment it slipped off the south-east bearing.

Condition of the Two North Hangers.—Almost identical pictures were presented by the north-west and north-east hangers [Figs. 6, 7 and 8]; lower pin in place, apparently not rotated, its top half wiped clean of grease; rear (north) centring plates untouched; front centring plates gone, or at least torn loose, and showing horizontal shearing of the bolts; and practically no damage except to the respective inner hanger chains, which had to tear out through the end strut. The movement of the north end of the span was evidently straightforward, in the direction of mid-span. As might be expected, both lifting girders tipped forward during the fall; the north-east one shows the strongest evidence of tipping.

The north mooring span was appreciably warped; the lower end was rotated clockwise, probably from the sequence in which the four mooring lines parted. This damage appears to have no relation to the other evidence or to the cause of the fall. At the north-west hanger the two forward centring plates were gone. The bridles were gone; the east bridle hitch angles had the south end bent inward slightly. The west hanger chain was untouched. At the east chain the connecting link was slightly bent to the west, and the pin through the box hanger was moved a bit to the west. The edges of the bracket plates on this box hanger showed some damage. The upper edges of the rear tie plates on both box hangers had come into contact with the link, showing rotation. The rocker pin had longitudinal scratches and its front end was scored.

On the north-east lifting girder the south-east centring plate was gone, and the south-west plate off, but lying near by. The cover plate of the girder showed a small bend at its front edge. The east hanger chain was undamaged except for slight bending of the rear tie-plate of the box hanger, which had come into contact with the connecting link by rotation of the girder. The west chain showed the same effect more strongly, the tie-plate being bent and torn; here the outer rear corners of the connecting link were scored. The link also had a bend to the west, and the pin through link and box hanger was pushed westward a trifle.

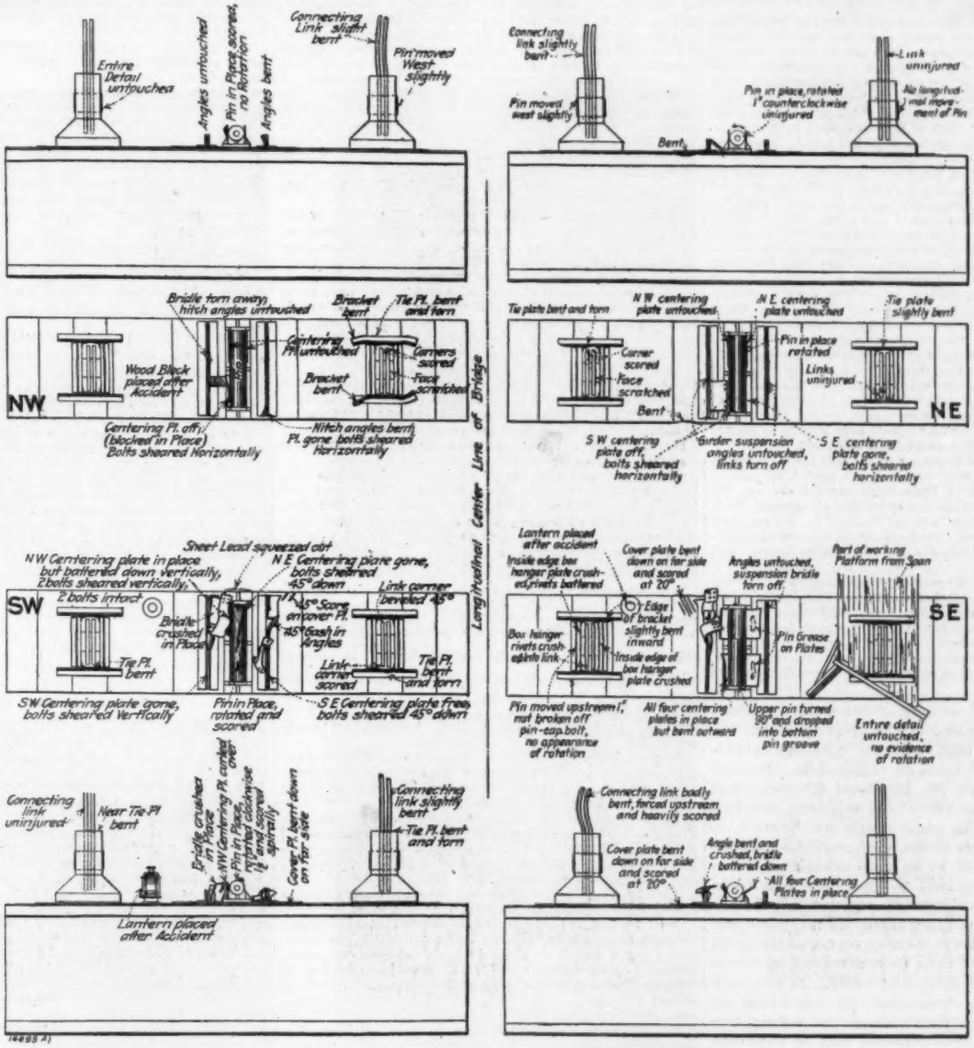

Entire Detail untouched
Angles untouched
Pin in Place, scored, no rotation
Angles bent
Connecting Link slight bent
Pin moved West slightly
Connecting link slightly bent
Pin moved west slightly
Pin in place, rotated 1° counterclockwise uninjured
Link uninjured
No longitudinal movement of Pin
Bent
Bridle torn away, hitch angles untouched
Bracket bent
Tie Pl. bent and torn
Centering Pl. untouched
Corners scored
Face scratched
Wood Block placed after Accident
Bracket bent
NW
Centering Pl. off (blocked in Place) Bolts sheared Horizontally
Hitch angles bent, Pl. gone bolts sheared Horizontally
Tie plate bent and torn
NW centering plate untouched
NE centering plate untouched
Tie plate slightly bent
Corner scored
Face scratched
Bent
Pin in place rotated
Links uninjured
NE
SW centering plate off, bolts sheared horizontally
Girder suspension angles untouched, links turn off
SE centering plate gone, bolts sheared horizontally
Longitudinal Center Line of Bridge
Sheet Lead squeezed out
NW Centering plate in place but battered down vertically, 2 bolts sheared vertically
NE Centering plate gone, bolts sheared 45° down
2 bolts intact
SW
45° Score on cover Pl.
45° Gash in Angles
Link corner bevelled 45°
Bridle crushed in Place
Tie Pl. bent
Link corner scored
Tie Pl. bent and torn
SW Centering plate gone, bolts sheared Vertically
Pin in Place, rotated and scored
SE Centering plate free, bolts sheared 45° down
Lantern placed after accident
Inside edge box hanger plate crushed, rivets battered
Cover plate bent down on far side and scored at 20°
Angles untouched, suspension bridle torn off
Part of working Platform from Span
Edge of bracket slightly bent inward
Inside edge of box hanger plate crushed
Box hanger rivets crush edge link
Pin Grease on Plates
SE
Pin moved upstream 1", not broken off pin-cap bolt, no appearance of rotation
All four centering plates in place but bent outward
Upper pin turned 90° and dropped into bottom pin groove
Entire detail untouched, no evidence of rotation
Connecting link uninjured
Near Tie Pl. bent
Bridle crushed in Place
NW Centering Pl. curled over
Pin in Place, rotated clockwise 1/4" and sheared spirally
Gauge Pl. bent down on far side
Connecting link slightly bent
Tie Pl. bent and torn
Lantern placed after Accident
Connecting link badly bent, forced upstream and heavily scored
Cover plate bent down on far side and scored at 20°
Angle bent and crushed, bridle battered down
All four Centering Plates in place
14895 A

FIG. 8.

The Fall of the Span a Simple Sequel to Failure at the South-west Support.—The above description of conditions tells its story fully. When the south-west support moved away from under the span, the long and heavy 640-ft. span could not maintain its integrity; its laterals, sways and portals were incapable of holding it together when resting on only three supports.

That the span kept up its integral action long enough for complete failure of the south end to precede the fall of the north end, however, is excellent testimony to its good construction. In this respect the photograph [see ENGINEERING, September 29, page 306] of the falling mass and the investigational evidence are in most perfect accord. The photograph caught the moment just preceding the dropping of the south-east corner, and it shows the north end still maintaining full alignment and verticality, although both trusses are practically horizontal at their south end and the lateral system is completely wrecked.

Coming to a period a few moments later, the happenings are recounted by the story recorded on the lifting girders. The north corners remained in place until the south end had cleared entirely and was falling free, and then they both slid off forward into the stream. Only a slight twist had been transmitted through the bridge, just enough to let the lower end strut crowd the inner chain of each hanger over to the west and by the same impulse push the pin of the box hanger in westward direction.

Strength Exhibited by the Three Rockers.—A point of great moment, in view of the failure of the south-west rocker, is the clear evidence that lies in the investigational findings as to the behaviour of the other three rockers. These rockers remained intact throughout, as is amply proved by the absence of severe punishment to the girder cover plate, hitch angles and shoe. They held the truss corner high above the lifting girder, so that it slid off without touching the girder, or at best barely grazing it. Yet these rockers were subjected to a severe duty, the south-east rocker had to carry, in addition to its normal load an extra reaction great enough to wreck the portal and lateral system of the bridge, and the unknown impact produced by the start of the failure. At the same time it was subjected to extreme canting and ripping actions, continued to the point of concentrating the whole load on one corner and forcing the rocker out of its seat. The north rockers bore nearly as severe a tipping effect, and they, too, held up intact.

The span rested on these same rockers for five weeks at Sillery, and they bore variously in that time about 10 per cent. more load than they carried during the hour and a half in which the span was suspended from the cantilever arms before its fall. This extra load was due to a very heavy material track (removed before the floating) on which ran a locomotive crane and material cars.

The destruction of the south-west rocker therefore did not develop from inherent weakness in the design, even though the rocker may have been overstressed (on the commonly used assumption of uniform load distribution along each pin, the maximum tension in the base would be computed at about 30,000 lb. per square inch). Defects in the south-west rocker made it weaker than its three mates.

This very careful account of the evidence which remains as to the cause of the accident makes the matter perfectly clear, and our contemporary is to be congratulated upon its publication. In view of the fact that the St. Lawrence Company had sought the advice of many able engineers, and had placed themselves in their hands we hesitate to criticise. Nevertheless the design of the rocker bearings seems to us to be very unsatisfactory in view of the immense load of some 1,300 tons to be imposed on each. It must be remembered that as soon as the span was lifted there was no longer any need for rocker bearings, as each corner of the great girder was suspended from the corresponding corner of one of the cantilevers quite freely. It was only during transit on the barge that the rocker bearings could serve any purpose. Once the lifting was commenced they were superfluous and, as the event showed, an imminent source of danger.

STARTING DIESEL ENGINES WITH LOW COMPRESSION.

To the Editor of Engineering.

Sir,—In your issue of September 22 you reproduce a paper by Professor W. H. Watkinson, of Liverpool, read before the British Association at Newcastle, and entitled "Starting Diesel Engines with Low Compression."

The paper appears to me to deal with a subject of immense practical importance, and to have some significance for the future development of engines other than those working on the Diesel cycle. One could have wished that Professor Watkinson had seen his way to give some details of the precise methods he employs for making use of the thermodynamic considerations to which he calls attention, and one would have greatly valued a much fuller treatment of the whole subject. I believe most engineers who have used large Diesels, and taken the trouble to note what is happening during the first few seconds that follow starting-up under compressed air, have been concerned at their tendency to develop enormous explosion—or shall we say, firing—pressures during those moments.

In the writer's opinion these abnormal pressures are not in the main due to abnormal richness of the charge—though this is no doubt a factor—but to the fact that the rate of temperature rise, and consequently the rate of increase of pressure, is enormously great compared with the rate of increase of volume due to piston movement. As soon as the engine gathers speed the phenomenon ceases, except in certain rare cases for which, apparently, no explanation is as yet available.

Professor Watkinson's suggestion that these dangerous pressures may be avoided by wire-drawing the entering air on the induction stroke appears to offer a delightfully easy solution to a real practical difficulty, and I do not doubt but that a large measure of success has been already attained.

No one is likely to challenge the theoretical considerations briefly outlined by the professor. We are all ready to agree that in compression the terminal temperature is a function not of the absolute pressure but of the ratio of compression, and that wire-drawing on induction will not materially lower the temperature of the incoming air.

I do not join issue until Professor Watkinson writes: "It should be as easy to obtain ignition temperature by compression to two atmospheres as it is to obtain it in the ordinary way by compression to 34 atmospheres."

A moment's consideration will show that this proposition could only be true of an engine in which the surface in contact with the operating fluid diminished in area—and so in power of absorbing and conducting heat—at the same rate as the rate of reduction in the weight of the charge.

But many other things are possible if we can thus dismiss all material considerations.

I venture to think that Professor Watkinson would fail to get ignition temperature at much higher pressures than two atmospheres; and even if that temperature were momentarily reached I do not believe there would be satisfactory burning of the charge.

As suggested above, the point that has been overlooked is this: Though the temperature of a gas in compression varies as the ratio of compression, or

$$\frac{T_a}{T_b} = \left(\frac{V_b}{V_a}\right)^{n-1},*$$

the quantity of heat, Q, which is contained in any given quantity of gas is directly proportional to the weight of gas taken, its specific thermal capacity at the temperature obtaining, and its absolute temperature.

That is to say, at any moment in such a cycle as we are considering $Q = W_T C$ where C is neither C_v or C_p.

Now, when Professor Watkinson wire-draws the incoming air, he reduces the weight of working fluid, and though the temperature of compression should in pure theory remain as before, the quantity of available heat is altered—almost in direct proportion to the accompanying reduction in compression pressure. Thus if P_b is the compression pressure attained in ordinary working, and $\frac{P_b}{n}$ the compression pressure attained when wire-drawing on induction, the corresponding quantities of heat involved at the said compression pressures stand to each other, as $Q_b : \frac{Q_b}{n}$. But the cooling surfaces in contact with the fluid remain the same, and these surfaces would abstract heat so rapidly from the small amount $\frac{Q_b}{n}$ available that an immediate fall of temperature would result.

In practice, with really low compression pressures, the fluid would never even approach the theoretical temperature. All the conditions would *tend* in the direction of compression at constant temperature.

In the writer's view this conclusion is supported by Figs. 5 and 6 accompanying Professor Watkinson's paper (ENGINEERING, vol. cii, page 290). As the professor points out, the maximum pressure is only a little in excess of the compression pressure.

The diagrams in question are indicator cards showing self-ignition at 250 lb. and 160 lb. compression.

Now assuming that effective combustion takes place, the difference between Figs. 2 and 3 on the one hand, and Figs. 5 and 6 on the other can best be explained, I think, on the ground of (1) excessive jacket losses as compared with the quantity of heat available, and (2) slower evolution of heat-pressure effect owing to slower burning in the less dense medium.

In venturing to call attention to these considerations the writer is not unmindful of the big debt all students of the internal combustion engine owe to Professor Watkinson, but the points do seem somewhat important, inasmuch as the kind of reasoning referred to is rather characteristic of much that has been written and said regarding these prime movers.

The oversight is exactly parallel with that so frequently noted in discussions on the value of high compression.

Students are still taught that thermodynamic efficiency varies directly with the compression of the charge, and in the vast majority of cases it is not even hinted that there must be a limit to the increase of efficiency with increase of compression, and this for the simple reason that as the compression volume V_b of the charge continues to diminish its ratio to the containing cooling surface S_b also continues to diminish; and obviously, at the limit, when V_b is infinitely small, S_b will be infinitely great compared with Vb, and the rates of heat leakage and temperature fall through the surface will be prodigiously big as compared with the quantity of heat Q_b available—a chief factor in this great rate of heat loss being the enormously steep temperature gradient between gas and metal and through the thickness of the metal.

I believe that in the Diesel engine the limit of economical compression—considered apart from other characteristics—has been greatly exceeded, and that the constant-pressure line when visible in the diagrams—and it is by no means as frequent a feature as some text-books represent it—is as much an effect of heat leakage as of gradual burning.

As I have probably already said enough to get me into serious trouble, I may as well fill up the cup of my transgressions by asking through your columns two questions:—

1. Is it not true that when a Diesel engine is working at maximum thermal efficiency the maximum pressure almost invariably considerably exceeds the compression pressure? and, further,

2. Is it not a fact that fuel in most cases must be entering the combustion chamber after the expansion curve, as read on an indicator card, begins to mark a fall of pressure, and that this is so notwithstanding that the valve itself may have actually closed at a point in the time-cycle previous to the fall of pressure becoming evident?

I know of no published investigations that either establish or contradict these propositions, though possibly the work has been done. If not, who is better qualified than Professor Watkinson to clear them up?

In the meantime I feel myself free to hold, with some diffidence, the opinion—held consistently, I believe, by Professor Burstall—that eventually the Diesel cycle will be replaced by another more closely assimilated to the extremely complex, and at present obscure, phenomena which take place millions of times a day in the cylinders of internal-combustion engines.

Apologising for this rather long intrusion on your valuable space.

I am, Sir, yours truly,
W. A. Benton.
Bentons Patents, Limited, 5, Grosvenor-chambers, Broad-street, Birmingham.

* I take it that n is 1.41, and that no account is taken of wall-action. If wall-action is assumed the equation is not true.

DRAUGHTSMEN.

To the Editor of Engineering.

Sir,—Referring to the discussion respecting draughtsmen, the point might be raised as to what is a draughtsman—what is he for, and what does he do, and why is his average wage set at 2*l.* per week?

Are not his duties superior to the shop foreman who can get 4*l.*? Must he not do all the work required by a manager of works at 6*l.* a week? Are the drawing office duties as follows: First to create something which has not been done before, by which he must have some superior knowledge; make all the working drawings down to the last gauge of screw so that the workman may not think? Must he not guide the shop foreman; must he not measure up quantities and kind of material required; must he not send down the actual order for the material; is he not held responsible always for the result of any engineering production?

Finally, do not firms requiring all this advertise for a man of experience, 20 years of age, salary to good man 35*s.*; no others need apply?

Yours truly,
An Old Hand.

The Waste of Wood.—There are more than 48,000 sawmills in the United States, says *Power*, New York, and their by-products in the form of sawdust, shavings, slabs and other wood refuse is estimated at 36,000,000 cords a year, one-half of which, perhaps, serves a useful purpose as fuel under the boilers. Much of the remaining 18,000,000 cords not only is not utilised, but generally is a source of danger and costs the mill time and money to dispose of in various ways. The production of waste is unavoidable, and the Forest Service is seeking out some way of turning it to account.

The Interconnection of Electricity Supply Systems.—Representatives of nearly all the electrical authorities in Lancashire and Cheshire have assisted in getting out a scheme for the interconnection of the electric stations in the counties so that they may act as reserves or stand-bys to each other, thus reducing the amount of reserve plant, the risk of interruption, and the running costs. They have divided the area into six groups, of which five seem to lend themselves to the scheme of interconnection. Estimates of cost and saving have been got out, and it is considered that the consumption of coal per unit generated would be reduced from 3.24 lb. by not less than 0.5 lb. At the price of 17*s.* 6*d.* per ton this would represent an annual saving of 82,000*l.* At the present price of 45*s.* it would represent much more. The majority of the undertakings are operated on the three-phase system with 6,600 volts as the pressure of generation and transmission, and at 50 periods. The only notable exception is the Lancashire and Yorkshire Railway Company's undertaking, worked at 25 periods, and it is proposed to omit this from the scheme. What is now wanted is a joint committee with powers to co-ordinate the electric supplies in the various districts and to raise the necessary money. An interim report has just been published with particulars regarding the various undertakings, their size, output, machinery, demand, &c. In this connection we may state that a Joint Committee on National Electric Power Supply has been appointed by the Incorporated Municipal Electrical Association and the Incorporated Association of Electric Power Companies, to consider the question of linking-up in all its aspects, and a memorandum has been issued by the Secretaries, Caxton House, Westminster, S.W., pointing out how improved results can be brought about in the future. The memorandum includes a map of England; on it are marked the suggested sub-divisions.

NICKEL STEEL SCALE.

*Notes on Nickel Steel Scale and on the Reduction of Solid Nickel and Copper Oxides by Solid Iron.**

By Dr. J. E. Stead, F.R.S., Vice-President.

It is well known that when steel containing 3 or 4 per cent. of nickel is heated to between 800 deg. and 1,100 deg. C. a scale is formed in course of time which is not readily detached from the steel itself, and in this respect differs from the scale which forms on the surface of other steels which are free from nickel.

Many years ago, on examining a polished section cut through a piece of nickel steel and the adherent scale, it was seen that the scale, where it came into contact with the metal, contained some metallic portions common to both scale and metal. There was no clear division between the two. At short spaces apart portions of the metal attached to the mother metal projected into the scale and tied it down. It was assumed at the time that the iron was oxidised in advance of the nickel, and it was the nickel that remained behind and was responsible for the strong adherence to the metal.

No attempt was made at the time to separate the metallic part of the scale, but recently an interesting specimen led to further investigation, and it is the result of this investigation which constitutes the first of these notes. The specimen referred to consisted of an ignition tube of a gas-engine after it had terminated its useful existence. It was made of steel containing about 25 per cent. nickel, and during its life had been heated most strongly in the part midway between the socket and the upper termination. At this place the original metal was oxidised to such a degree that all of it was very brittle scale.

At the parts above and below this point some non-oxidised metal appeared, as shown in Fig. 1.

On examination of a complete section through *aa*, the appearance was as shown in Fig. 2. The fracture through *b* was black, whilst through *a* it was grey. The outer layer *b* consisted of completely oxidised metal, the under layer *a* consisted of scale in which were embedded bright particles of metal, and the quantity of free metallic particles diminished as the distance from the unoxidised metal was increased. The layer *a* was crushed to powder, and the metal separated magnetically from the less magnetic scale; it was then cleaned by further crushing and washing until only cinder-free metal was left. This was tested and found to contain:—

	Original Metal.	Oxidised Residual Metal separated from Scale.
	Per cent.	Per cent.
Nickel ...	25	76

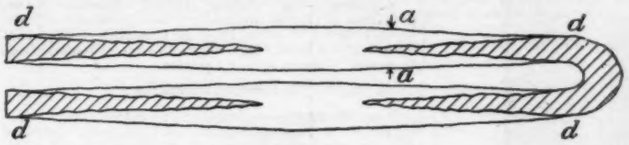


Fig. 1.

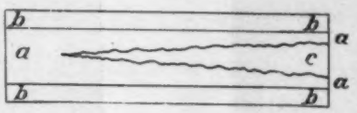


Fig. 2.

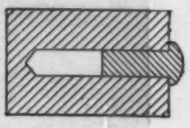


Fig. 3.

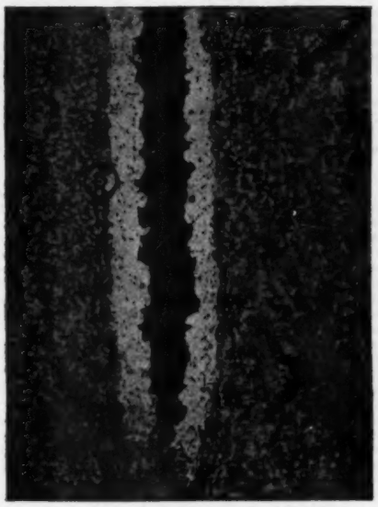


Fig. 1a. Section through the Wall of a 25 per cent. Nickel Steel Ignition Tube after Long Use. Etched with Stead's Cupric Reagent. × 53.

Fig. 1b. Same as Fig. 1a, Greatly Magnified, showing How and Where the Oxides are Formed.

Fig. 2a. Nickel Steel (7 per cent. Nickel) after Long Heating in Air, showing Junction between Unoxidised Metal and Scale. Polished only. × 50.

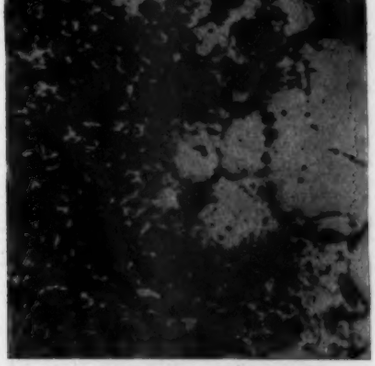


Fig. 2b. Same as Fig. 2a, More Highly Magnified.

Having noticed that copper is not so readily deposited from alcoholic cupric solutions by the alloys richer in nickel, a solution of copper was applied to the polished section referred to above, and, as was expected, whilst copper deposited readily on the central part of the tapered section c, it did not deposit on the borders of this or on the free metal particles in the scale. At the points *d* (Fig. 1), where the heat had been less and the scale was thinner, copper deposited equally all over the surface of the unoxidised metal. Where the temperature had been lowest and the scale very thin, such scale as there was proved to be free from metallic particles.

The relative action of the copper solution on the less nickeliferous metal is clearly shown in photographs Nos. 1a and 1b. It is evidence that under the conditions of heating, which was continued for many months, the iron was selectively oxidised and the nickel concentrated in the outer part of the metal. It suggests that the iron diffused outwards from the mother metal, leaving a concentration of nickel in solid solution behind. This outer layer, however, was not all metallic: there were oxide inclusions between the polygonal grains, suggesting that oxidation proceeds along the crystal junctions and that the iron diffuses to these oxide-enveloped crystals, leaving a broken up envelope of metal richer in nickel than that part into which oxides had penetrated.

It is certain that when the oxidation is intense the metal is oxidised as a whole—a condition obtaining when the scale on the surface is thin, but when the scale becomes thicker oxidation is retarded and the iron then is more rapidly attacked than the nickel.

An experiment was next made by heating a nickel-iron alloy containing about 7 per cent. nickel to 1,000 deg. C. for 24 hours. The results confirmed anticipation. The layer of scale was very adherent to the metal, the reason being that metal and cinder were intermingled at the junction of the two. Photographs Nos. 2a and 2b clearly show this.

Conclusions.

1. The concentration of nickel in the outer layers of nickel steel, when long heated at about 800 deg. to 1,000 deg. in air or other oxidising gases, is due to interdiffusion of iron and nickel and the removal of iron as oxide at the surface of the metal.

2. That the oxidation follows the crystal junctions of the metal and the grains become surrounded by oxide, and eventually the last parts of the metallic crystals become independent inclusions in the oxide scale and very rich in nickel.

3. That the scale is adherent to the metal owing to the interpenetration of the metal and oxides.

On the Reduction of Solid Oxides of Nickel and Copper by Solid Iron.

Consideration of the results in the previous note led to a trial to determine whether solid oxide of nickel and solid oxide of copper would react on solid iron at temperatures far below their melting points.

Several pieces of 1-in. round bar of Armco iron containing 0.02 per cent. carbon were drilled down the centre and filled respectively with nickel oxide and copper oxide and consolidated by forcibly driving down a plug of the same iron. The dimensions were as shown in Fig. 3 annexed.

The bars with enclosures were then placed in a muffle furnace and heated to about 1,000 deg. C. for about six hours a day for three days. When drawn from the muffle they were sectioned by sawing vertically through the centre, and were examined, with the following results:—

In the centre of the piece in which nickel oxide was placed there existed a mixture of metallic nickel and some kind of oxide, part of which fell out during the grinding and polishing. Attached to the sides, top and bottom of the iron cavity were particles of almost oxide-free nickel, whilst adjoining the iron a layer of cinder or slag existed (photographs Nos. 3a and 3b, page 368) Photograph No. 3b represents the junction through these adherent layers shown in photograph No. 3a, and the consolidated nickel near the top just under the end of the plug.

There is evidence that the solid oxide of nickel was substantially reduced by the solid iron at temperatures far below the melting points of the oxides or metals. The portion which fell out of the cavity during polishing consisted of spongy nickel and presumably iron oxide. The nickel particles when highly magnified were found to be more or less globular. It is remarkable how the nickel near the walls of the cavity had become consolidated. This, of course, could only be the result of surface tension.

The experiment with copper oxide proved that a

* Paper read before the Iron and Steel Institute, September 22, 1916.

similar change had occurred as with nickel oxide, and what was left in the cavity was metallic copper and iron oxide.

Other trials with the same oxides, but by heating at about 780 deg. C. instead of at 1,000 deg. C. for 24 hours, yielded similar results, but the oxides were not so completely reduced, although considerable quantities of non-coherent metallic nickel and copper were formed.

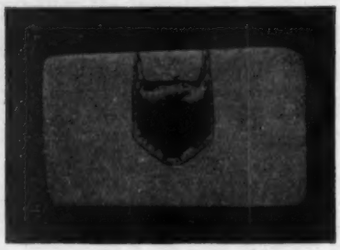


Fig. 3a. Nickel Oxide Heated in a Cavity of Armco Iron at 1000 deg. Cent. The White Parts Inside the Cavity are Nickel. Polished only. × 1¼.

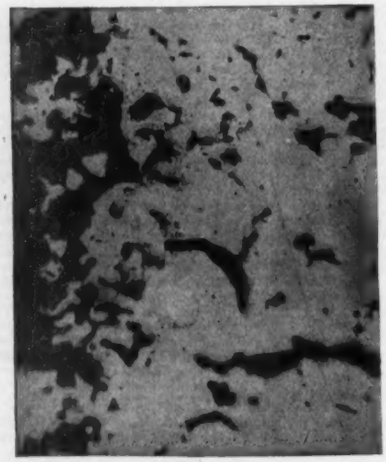


Fig. 3b. Same as Fig. 3a, more Highly Magnified, × 330. Polished only. The Dark Parts are Oxide, the White Parts Nickel.

Photographs Nos. 4a and 4b illustrate the section through the piece of iron in which copper oxide had been placed, after heating to 780 deg. C. The central dark part represents unreduced copper oxide; the light-coloured layer the metallic copper; the darker parts are oxide of iron and porosities.

Photograph Fig. 5 is taken from a section of the iron and copper oxide experiment which had been heated to 1,000 deg. C. It was etched with nitric acid. Note that there are four different layers, as follows:—

1. The original iron of coarse structure.
2. A second layer of fine structure.
3. A third well-defined layer of oxide in which there are inclusions of copper.
4. A layer of spongy copper containing oxide.

Conclusions.

1. It has been proved that solid iron is capable of reducing solid oxide of nickel and oxide of copper to the metallic state with the formation of iron oxide.
2. That the interchange is not confined to the surfaces of contact but extends for a considerable distance from the surface of the iron, suggesting that there is inter-diffusion of iron and nickel and iron and copper, and of the oxides of these metals.
3. That surface tension plays an important part in causing the reduced metals and the oxides to segregate into coherent independent masses.
4. There is some evidence that the reduced metals, copper and nickel, are alloyed with some iron. More research is being made to determine whether this is so.

FOREIGN ENGINEERING PROJECTS.

We give below a few data on several foreign engineering projects, taken from the *Board of Trade Journal*. Further information on these projects can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, E.C.

Russia.—The British Vice-Consul at Baku has forwarded, under date August 15, a copy of a specification, together with plans, in connection with a call for tenders by the mayor of the municipality of Baku for the supply, delivery and erection at the Sumgait pumping station of the Baku waterworks of (*a*) two double-acting plunger pumps to be operated by 400-h.p. Diesel motors already

Fig. 4a. Oxide of Copper Heated in a Cavity of Armco Iron at 750 deg. Cent. Not Etched.

Fig. 4b. Same as Fig. 4a. Polished only, showing Dark Core of Copper Oxide and Mixed Layer of Iron Oxide and Free Copper.

Fig. 5. Oxide of Copper Heated in a Cavity of Armco Iron at 1000 deg. Cent. Etched with Acid. × 50.

installed; (*b*) two four-cylinder type Diesel motors of 600 h.p. each, with two double-acting plunger pumps for same; and (*c*) a traveller crane of 19 m. span, capable of lifting the heaviest parts of the plant; together with all accessory and spare parts required. No date has been fixed for the receipt of tenders, but early delivery is required. Firms intending to tender should notify the municipal authorities by telegraph both of their intention and, later, when the tender is despatched. The municipal authorities will then await the receipt of such previously notified tenders before awarding the contract. If possible, prices should be quoted delivered at Baku, including cost of transport and duty. In view of the fluctuations in exchange it would probably be well for British firms to quote in sterling.

Argentina.—The *Boletin Oficial*, Buenos Ayres, publishes a Decree approving plans presented by the Buenos Ayres Western Railway Company for the construction of a branch line, about 16½ km. (10 miles) long, from the "Colonia Alvear" station.

The Influence of Elements in Steel.—In a paper by Mr. W. A. Janssen, recently read before the American Foundrymen's Association and reproduced by *The Iron Trade Review*, Cleveland, Ohio, the author states that notwithstanding all that has been said concerning the harmful effects of phosphorus and sulphur in steel, the occluded oxides and gases, such as iron oxide, Fe_2O_3, and an indefinable oxide, probably FeO, free oxygen, nitrogen and occluded slags are the real causes of many of the troubles of the steel-maker. In this the author is at one with Dr. Stead. The object of Mr. Janssen's paper is to point out some advantages of ferro-titanium as a deoxidiser; it states that titanium does not rectify all the existing evils in the production of steel castings, but it goes a long way towards making good steel better.

The Hardening of Oils.—Many contradictory statements have been made as to the catalytic agents with the aid of which oils, difficult of purification, can be converted into hard fats or other compounds admitting of purification. Nickel and its oxides are foremost among the catalysts. But while some chemists recommend oxides, others consider the metal equally effective. In any case it is generally believed that apparently insignificant features of the preparation of the catalysts have a very remarkable influence. The *Chemiker Zeitung* of September 6 brings an account of a new investigation of this problem by Dr. W. Normann. In disagreement with E. Erdmann, who had recently worked on the same subject, he finds that metallic nickel, is, technically used under proper conditions, always more effective than the nickel oxides, and that nickel is far less sensitive to so-called poisons interfering with the catalysis than had been believed. When reduced from its oxide under certain conditions, nickel is not to be recommended; but on the whole it seems certainly not to be inferior to the oxides. Some chemists have insisted that nickel (and also its oxides) should be used together with a carrier such as infusorial earth, charcoal, or kaolin. According to Normann the carrier is not essential.

The Late Mr. Percy Webberley.—We regret to record the death of Mr. Percy Webberley at his home at Longton, Staffordshire, on the 6th inst., at the early age of 37. Mr. Webberley was the assistant electrician in the Board of Trade Electrical Standards Laboratory from August, 1908, until June, 1915, when he retired through failing health. He was educated at Mason University College, Birmingham, 1896–99, where he took the Electrical Engineering Diploma. He was an improver at Messrs. Bellis and Morcom, and acted for some time as assistant in the Electrical Engineering Department of the Northampton Institute, Clerkenwell. After this he was employed in the Westminster Electric Supply Corporation for four years in testing and maintaining instruments in the generating station, under Mr. C. O. Grimshaw, when he took first place in laboratory work in the electro-technics examination, and second in theoretical work at Finsbury Technical College. He matriculated at the London University in 1902. He was selected from a considerable number of candidates for the post in the Board of Trade, on account of his knowledge of electric meters and of electrical measurement and testing. He was a careful and accurate worker and a genial and attractive colleague.

Sweden's Production of Iron Ore.—The Swedish Department for Commerce has now published a report on the production of iron ore in Sweden during last year. In spite of difficulties arising from the war, the Swedish iron industry did well on the whole during 1915, and the production of iron ore, including concentrates, amounted to 6,883,308 tons, against 6,586,630 tons in 1914, an increase of about 300,000 tons, or 4.5 per cent. With the exception of the Upsala and the Norbotten districts, all the iron ore mines show an increase. This more especially refers to the Kopparberg, Orebro and Vastmanland districts. The diminution in the production of iron ore in Norbotten (Lapland) amounted to no less than 467,520 tons, owing to the manner in which shipments *via* Narvik have been impeded. The decrease principally relates to the Kirunovoors iron ore deposits, from which the production receded from 2,728,363 tons in 1914 to 2,076,512 tons in 1912, or more than 650,000 tons. It should be noticed in this connection that the Gellivora ore used for concentrate at Hoganöss, West Sweden, is not included in the total for 1915. The aggregate value of iron ore produced in Sweden during last year amounted to 52,933,870 kronen. The production of pig-iron showed an increase of 120,983 tons, or about 0.19 per cent. The value of the year's production of pig-iron, which is the highest on record, amounts to 70,877,179 kronen, or an average of 93 kronen 17 öre per ton, against 81 kronen 77 öre per ton for the preceding year. (18 kronen = 1*l.* at normal rates of exchange.)

STEEL INGOT DEFECTS.

*Principles affecting Acid and Basic Open-hearth Steel and Bessemer Steel.**

(INTRODUCTORY PAPER.)

By J. N. KILBY (Sheffield).

IN pursuing any investigation it is advisable to level circumstance down to rock bottom, laying bare every possible source of information. It is imperative to put aside personal and old-time prejudices, otherwise research and opinion are valueless. Throughout the steel trade one finds separate schools; some following hypothetical dogma, not actually bearing even upon the science or the practical side of the business; others, though engaged upon theoretical lines, are helpful, inasmuch as endeavouring to expose faulty material. Last, we have the actual makers, who are themselves again divided into their own particular little sphere according to training and beliefs.

A good many firms have built research laboratories. Some use them well, whilst to others their usefulness ends in the advertisement they give, being a show place only. There is rarely any communication between the research chemist and the steel-maker, or even exchange of opinions and ideas. Each possesses his little square of working ground, and is not allowed to encroach upon the others.

No place was, until recently, surrounded by a bigger wall of prejudice than the core of what has been called the hub of the steel trade, and with the exception of a few firms and individuals the clinging to oldest and routine processes is to-day as strong as ever. Any suggested deviation from the beaten track usually brings forth the answer, "Our fathers built their trade on this method. It was good enough for them; it is good enough for us."

Any sound point gained by experience admittedly must be retained, but it is also expected that methods which have no real value, except their antiquity, should be relegated to their proper place.

Brands of iron and mixtures have meant finality to a host of arguments upon the quality and defects in steel ingots. These may be very convenient when no other label can be found, but they are not conducive to improvement or economy. The virtue existent in the much-cherished brands of iron is purely one of consistency and not of extraordinary chemical or physical properties. Whether the steel be made from Swedish, West Coast or East Coast materials matters not as far as pipe, segregation and surface defects are concerned. These defects cover 90 per cent. of those found in steel ingots upon which this and further papers will deal. The defects mentioned are caused by bad type of mould and methods of casting. Faulty casting and mould type are directly responsible for most of our present-day tight-laced specifications. Engineers find, in spite of restrictions upon the sulphur and phosphorus content and demands for huge discard to be clear of pipe, that defects continually crop up, hence their firm opposition to relaxing their specifications.

INGOTS 3 TONS AND UNDER. BOTTOM-CAST STEEL.

Moulds and beds of numerous types are used to-day in the making of bottom-poured steel. Some of the moulds are absolutely unfit for the production of sound steel. Sketches A, B, C, D (Fig. 1), E, F, G, H and I (Fig. 2), show various types of both top and bottom cast ingots, and Table I. describes them. These are not shown to scale, and are for illustrative and comparative purposes only. They are based upon the cutting up of a huge number of ingots, done some years ago. Later experience has fully confirmed them.

Fig. 1. TYPES OF TOP CAST INGOTS

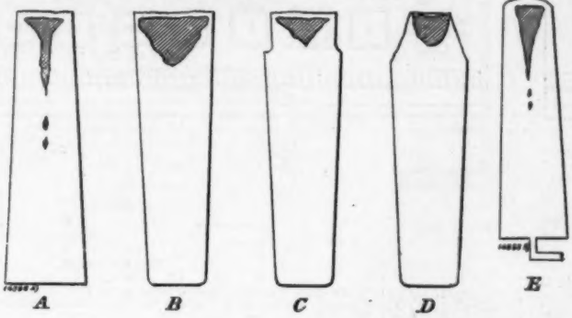


Fig. 2. TYPES OF BOTTOM-CAST INGOTS

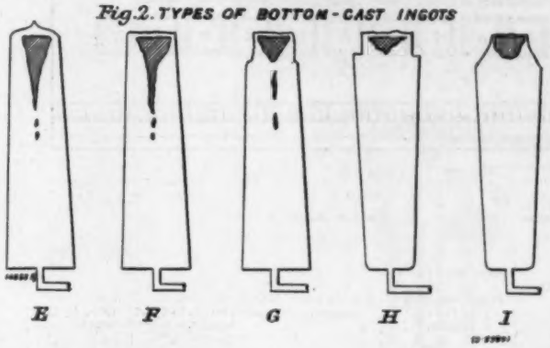
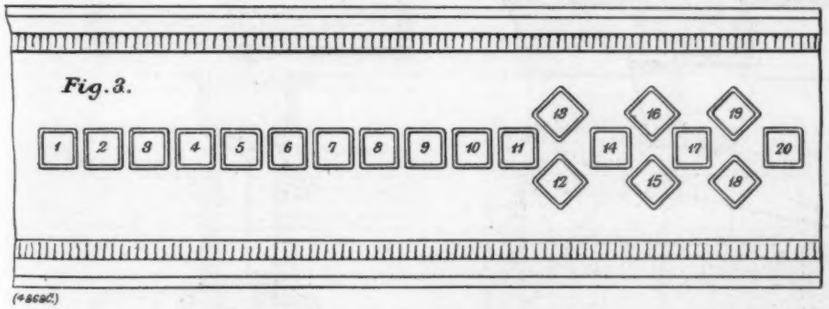


TABLE I.—DETAILS OF INGOTS.

Ingot.	Type of Mould Used.	Average Pipe and Segregate Zone.	Surface.	—	Ingot.	Type of Mould Used.	Average Pipe and Segregate Zone.	Surface.	—
A	Top poured, narrow end at top, no brick head, usual Bessemer mould	Up to 50 per cent. of the ingot. Liable to secondary pipe	Cracks and splash	Practically free from occluded fluxed brick.	F	Bottom-poured, narrow end at top, no brick top, open at top	Up to 60 per cent. of the ingot. Always has secondary pipe	Good	Same as E.
B	Top poured, wide end at top, no brick head	Up to 35 per cent. of the ingot. Traces of secondary pipe	Same as A	Same as A.	G	Same as F, but with brick head	Up to 40 per cent. of ingot. Nearly always has secondary pipe	Good	Same as E.
C	Same as B, with brick top	Under 12 per cent. of ingot	Same as A	Same as A.					
D	Same as B, with "sand" head	Same as C	Same as A	Same as A.	H	Bottom cast, wide end at top, adjustable brick head	Under 10 per cent. No secondary pipe	Good	Same as E.
E	Bottom-poured, narrow end at top, closed top	Up to 80 per cent. of ingot. Always has secondary pipe. Worst possible ingot for pipe and segregation	Good	Liable to occluded fluxed runner brick.	I	Bottom-cast as H, but with "sand" heads	Same as H	Good	Same as E.

Fig. 3.



Ladle Nozzles.	No. of Moulds.	How Tun Dished, &c.			—
Inches. 1 × ¾ or 1 × ½	20	*Ingot Nos.* 1 2 3 4	5 7 9 8 10	12 15 18 11 14 17 13 16 19	20
		Single tun-dishes ¾ in. to 1 in. nozzles.	Double tun-dishes ¾ in. to 1¼ in. nozzles.	Triple tun-dishes 1 in. to 1¼ in. nozzles.	Single tun-dish 1¼ in. nozzle.

For bottom-cast steel the only type of mould which is reliable is the one cast wide end up, the steel feeding the ingot through the central nozzle in the mould bottom, the mould having a feeder head. The only type of bed is one which is radial, the ingots being equidistant from the feeding trumpet.

TOP-CAST STEEL.

The type of mould most suitable for top-poured steel is the one wide at the top with feeder head. Steel cast direct from the ladle into the mould often cracks in rolling or forging, and is apt to produce unsound material. An 18-in. ingot cast direct may produce 3-in. billets, the defects being so fine as to escape ordinary inspection, and on first examination appear almost like superficial scratches. The pickling of such material would show up these defects; and also what a small percentage of top-poured steel is actually sound. The same ingot worked into, say, a 10-in. bar would yield as much unsound as sound material. The more "work" upon the steel, the more the defect is hid. It is present, nevertheless, Top-poured steel is more liable to cracks than bottom-poured steel on account of the quick rate the mould is filled, hot steel, of course, yielding worse than that cast at a moderate temperature.

Temperature of the steel depends a good deal upon the workman, who is liable to err on the high side. This is natural, seeing that he is usually paid per ton of ingots, and not upon the yield of sound material in the mill or forge.

The difference in temperature between what is termed a "hot cast" and one which runs nicely is not so great as is often supposed. No professor has yet been able to demonstrate or even lay out any definite lines for the maker to work upon. Mr. Harry Brearley's paper before the West of Scotland Institute is about the only practical paper aiming in this direction and illustrative of the effects of temperature.

TUN-DISHING FOR TOP-POURED STEEL.

To obtain the best results from top-poured steel the material should not be cast from the ladle into the mould direct, but should pass through a secondary ladle or tun-dish attached to the ladle or resting upon the moulds (Figs. 6 to 9). It may be a dish containing one or more nozzles according to the tonnage to be cast and the nozzle or nozzles in the large casting ladle. If tun-dishing is carried out thoroughly, the quantity of ingots suffering from cracks, whilst being rolled or forged, is reduced to a minimum. A number of firms have tried this method of

* Paper read before the Iron and Steel Institute, September 21, 1916.

top-casting steel; some have been highly successful, others have, unfortunately, not had this success. Failure in this class of work is brought about usually by expecting to do too much at once. The size or relative values of nozzles are not taken sufficiently into account, neither is the personal factor of the workmen. Steel does not require to be excessively hot to be cast in this manner. Drawings illustrative of tun-dishes and tun-dishing are given above. They are as a guide only. Each particular shop must have its own most suitable arrangement.

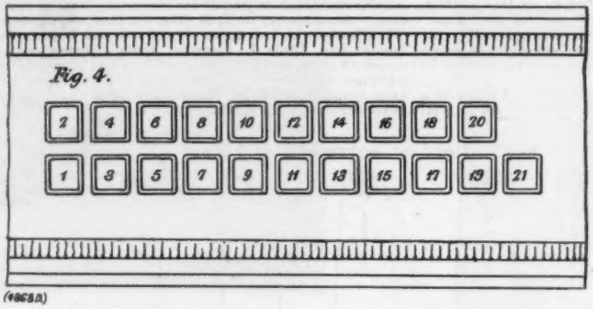
Suggested Practical Experiment.

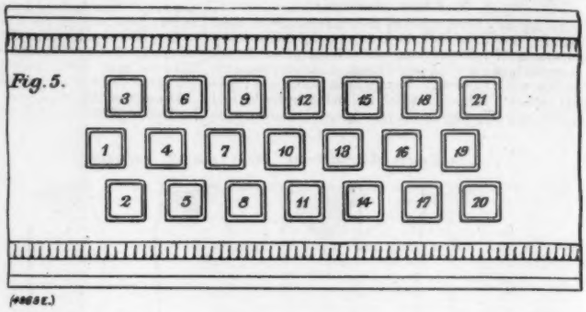
First make from the same heat two beds of bottom-cast ingots, say 15 in. square, having one of each type shown in the paper on each bed. Also two sets of each type of top-poured ingots; one set poured direct, the other set tun-dished.

Have one set of the bottom-cast and one set of the top-cast ingots sliced from top to bottom, cutting out the central ½-in. portion.

Roll the remaining ingots into, say, 7-in. bars. The bars to be marked from their position in the ingot. The bars then to be pickled in the usual manner to remove scale. After examination for surface defects each bar to have the central slice taken longitudinally and examined for pipe and segregation. The above experiment, though at first sight expensive, would save endless time and save useless argument in any works.

The effect of mould shape and ratio of cross-sectional area to length have influences upon the ingot produced. These points and others will be taken at a later date.





Ladle Nozzles.	No. of Moulds.	How Tun-Dished, &c.	—
Inches. 2 × ⅝ or 2 × ¾	21	*Ingot Nos.* 1 3 2 4 Single tun-dishes ¾ in. to 1-in. nozzles.	5 7 9 11 13 15 17 19 6 8 10 12 14 16 18 20 ¾ in. to 1-in. Double tun-dishes. nozzles. Remainder 1 in. to 1¼ in. nozzles.	21 Single tun-dish, 1¼ in. nozzle.

Ladle Nozzles.	No. of Moulds.	How Tun-Dished, &c.
Inches. 3 × ⅝ or 3 × ¾	21	*Ingot Nos.* 2 5 8 11 14 17 20 1 4 7 10 13 16 19 3 6 9 12 15 18 21 All single tun-dishes resting upon mould ¾ in. up to 1¼ in. nozzles or may be cast with 3 tun-dishes attached to ladle.

Fig. 6. Type of "Tun Dish;" Single Nozzle.

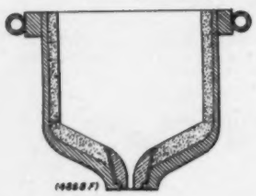


Fig. 7. Type of "Tun Dish;" Two Nozzles.

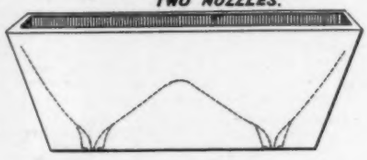


Fig. 8. Type of "Tun Dish;" Three Nozzles.

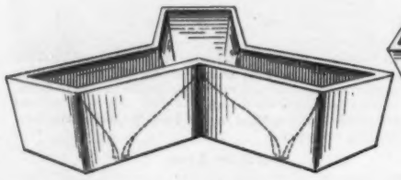


Fig. 9. Type of "Tun Dish;" Four Nozzles.

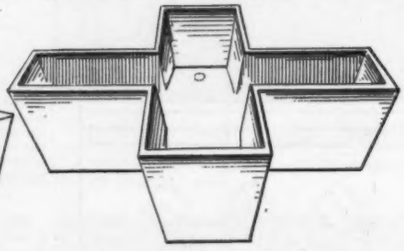


Fig. 10. Ladle &c. showing mode of casting with dish; may be on mould or attached to ladle.

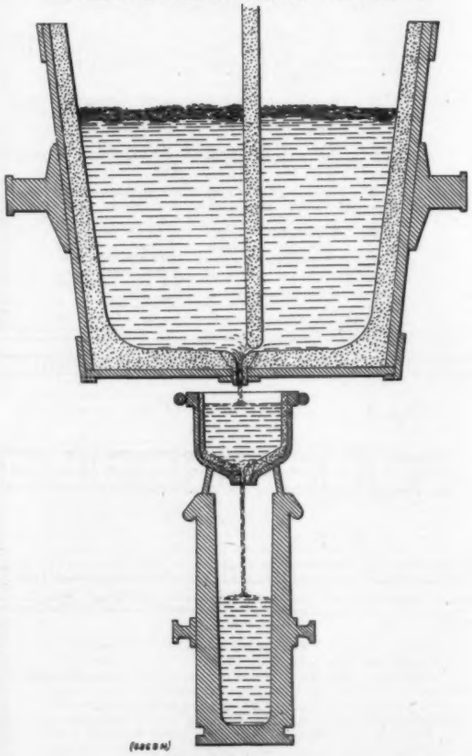
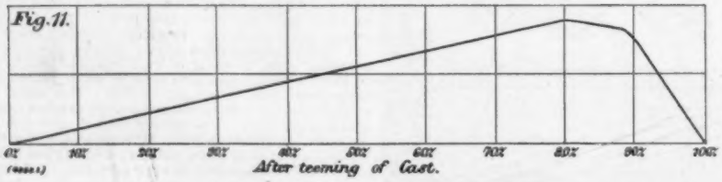


Fig. 11.



TEEMING VARIOUS WEIGHTS OF STEEL.

Tons of Steel.	Nozzles in Ladle.	Tun-Dishes.	Nozzles in Tun-Dish.
	Inches.		Inches.
10	1 × ½	Single, attached to ladle.	1
20	1 × ¾	Single tun-dish attached to ladle half of cast, remainder double tun-dishes resting upon moulds	1
30 to 45	2 × ½	Single tun-dishes attached to ladle for first 20 tons, remainder through double dishes resting upon moulds	1
35 to 45	3 × ½	Single tun-dishes attached to ladle.	1
50	1 × ¾	⅓ of cast single tun-dish. ½ of cast double tun-dish. ⅔ of cast treble tun-dish. ¼ of cast four-way tun-dish.	1
50	3 × ½	Single tun-dishes attached to ladle.	

On account of the teeming slackening at the last 10 per cent. of the cast, due to small amount left in ladle, the last few tons might require slight modifications.

American Coal Exports.—The exports of coal from the United States in April were 1,542,200 tons (viz., anthracite, 213,593 tons and bituminous, 1,328,607 tons), in May, 1,855,062 tons (anthracite, 450,785 tons; bituminous, 1,404,277 tons); and in June, 2,580,648 tons (anthracite, 515,139 tons; bituminous, 2,065,509 tons). Bituminous coal was also exported as follows during the three months for bunkering purposes: April, 579,502 tons; May, 741,167 tons, and June, 727,168 tons. The aggregate exports for the three months were, accordingly, 8,035,747 tons, equal to an annual export movement of 32,142,988 tons.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

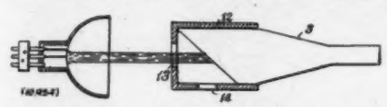
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

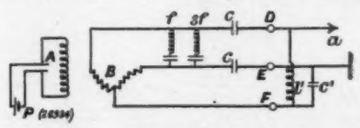
ELECTRICAL APPARATUS.

10,454/15. The British Thomson-Houston Company, Limited, London (*General Electric Company, Schenectady, U.S.A.*). **X-Ray Tubes.** (4 *Figs.*) July 19, 1915.—The present invention comprises an X-ray tube operating with a substantially pure electron discharge and having an anode 3 provided with a hood or longitudinal extension 12 of conductive material electrically connected to the anode. The hood extends from the anode over the face thereof and in part surrounds and



encloses the path of the cathode rays entering the target, but allows free egress of the X-ray beam. This target extension in most cases is constructed to suppress undesired primary and secondary cathode rays emitted from the face of the target. The hood or shell 12 consists preferably of metallic molybdenum or tungsten and contains an opening 13 for the admission of the cathode rays and an opening 14 for egress of X-rays. (*Sealed.*)

26,934/13. Societe Marius Latour et Cie, Paris, France. High Frequency Alternating Currents. (2 *Figs.*) November 22, 1912.—The rotor of a high-frequency machine is fitted with a single-phase winding A excited by a source of direct-current P. The stator is fitted with the two-phase winding B. What are known as "filtering currents" *f* and 3*f* are shunted across the outer end of the winding B. These circuits are adjusted for resonance for currents of frequencies *f* and 3*f* respectively. C, C, are capacities for balancing the self-induction of the stator winding for the frequency 5*f*. Two-phase current of this frequency is obtainable at the terminals D, E, F. In order to



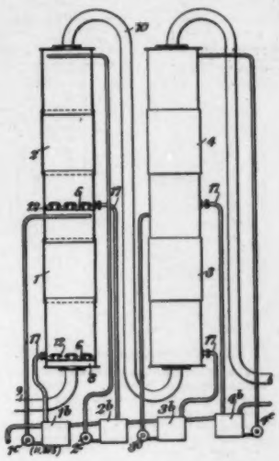
utilise the two-phase currents for feeding an antenna, according to the present invention, a self-induction l^1 and a capacity c^1 are connected between the common terminal F and the terminals D and E respectively, a wattless current being thus produced which leads with respect to the current in one phase and lags with respect to that in the other phase, and which has approximately the same intensity both in the inductive circuit containing l^1 and the capacity circuit containing c^1. The result of this arrangement is that the current delivered by the machine to each terminal D, E, is less than that supplied to the antenna *a*. (*Sealed.*)

GAS-ENGINES, PRODUCERS, HOLDERS, &c.

10,196/15. J. R. Gray and Alder and Mackay, Edinburgh. Dry Gas Meters. (1 *Fig.*) July 13, 1915.—This invention relates particularly to the construction of the means for holding the diaphragm in dry gas meters. The metal plate *a* is provided with an opening *b*, the edge of this opening being formed as two U's *c* and *d*, one inverted with respect to the other, and one limb of the two U's being common to both. This formation continues all round the opening. The usual diaphragm *e*

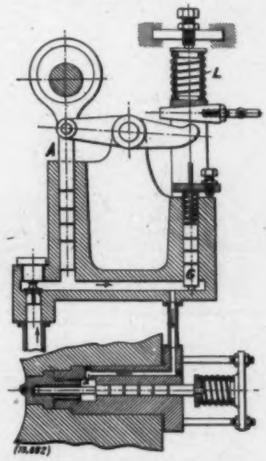
covers the opening *b* and the U's. Into the outer U, namely *c*, and above the diaphragm, there is inserted a metal ring *f* in part of U section, but having a projection *g* at an angle to one limb of the U, making it rather in the form of a small script V. This ring *f* may be continuous or may be made in parts. The U and V formation are such that they are not sufficient of themselves to hold the diaphragm, so that to complete the construction it is necessary to attach the edge of the V to the metal plate *a* by solder. (*Sealed.*)

11,315/15. British Coke Ovens, Limited, and F. M. N. Schuster, London. Gas Scrubbers. (4 *Figs.*) August 5, 1915.—1, 2, 3 and 4 represent four towers, the tower 2 being mounted upon the tower 1 and the tower 4 similarly mounted upon tower 3. Each pair of superimposed towers is divided substantially midway of its length by a baffle plate 5. Baffle plates 6 similar to the baffle plates 5 are provided at the lower ends of the lower towers 1 and 3, and inlet openings are provided to admit the gases into a chamber 8 immediately beneath these baffle plates 6, these gases being conducted by means of a pipe 9 to the tower 1, and by means of a pipe 10 from the top of the tower 2 to the bottom of the tower 3. The baffle plates are formed with a number of openings from which hooded pipes 12 rise. In planes above the baffle plates outlet pipes 17 for permitting the scrubbing liquor to run off are provided, and these pipes are so located that a liquid level is maintained just below the tops of the pipes 12. Each outlet pipe is connected to a separate receptacle 1*b*, 2*b*, 3*b* or 4*b* respectively, and pumps 1*c*, 2*c*, 3*c* and 4*c* are provided to pump the liquor from these receptacles through pipes to the tops of the respective towers, into which the liquor is introduced as evenly as possible over the whole area by means of suitable distributing sprayers. The collecting receptacles 1*b*, 2*b*, 3*b* and 4*b* are connected in series, and the receptacle 4*b* has a pipe leading from a source of liquid supply, so that fresh liquid is continually entering the receptacle 4*b*, and the liquor from the receptacle 4*b* overflows to the receptacle



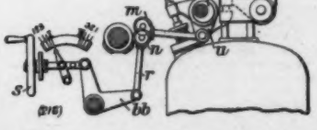
3*b*, liquor from the receptacle 3*b* overflows into the receptacle 2*b*, and from the receptacle 2*b* the liquor overflows to the receptacle 1*b*, from whence it passes to a collecting tank or reservoir, where it can be pumped for further treatment. (*Accepted July* 19, 1916.)

13,882/15. Sir K. I. Crossley and J. Hutton, Manchester. Oil Engines. (1 *Fig.*) September 30, 1915.—The invention refers to that type of engine in which the oil fuel is delivered by means of a cam-operated or eccentric-operated plunger pump into the compressed and heated air in the combustion chamber at or about the end of the compression stroke. To prevent any damage being done to the pump pipes or other parts in case of



any obstruction occurring to the oil pipes, passages or sprayer, the patentees provide a second plunger G, the barrel of which is in open communication with the barrel of the pump plunger A. A strong spring L is provided, which prevents any outward movement of the safety plunger until the oil pressure in the pump rises to an abnormal extent owing to some abnormal obstruction to the delivery of oil occurring somewhere in the oil pipes, passages or sprayer. (*Sealed.*)

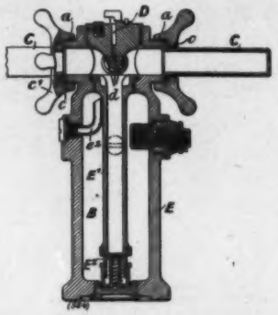
216/15. B. E. D. Kilburn, London. (*Gebruder Sulzer Aktiengesellschaft, Winterthur, Switzerland*). **Internal Combustion Engines.** (3 *Figs.*) January 6, 1915.—The invention relates to a reversing and regulating gear of the kind in which valve-operating rollers actuated by cams are employed for controlling forward and backward driving and the charge of the engine while the latter is running. According to this invention, the valve controlling rollers *m*, *n* are connected, on the one hand, to levers *u* adapted in a well-known manner to open the valves



and mounted on an eccentric *b* by means of which they can be put into or out of action and, on the other hand, to a manual control so that when the rollers are moved to one or the other end of a definite adjusting range, either for forward driving or reversal, full charge is admitted in either case, while the regulation of the charge alone is effected when the position of the rollers is varied outside the above range beyond the one or the other end position thereof. A separate set of such rollers may be employed for simultaneously adjusting the opening periods of a scavenging valve from the same manual control so, however, as to be independent of the subsequent regulation of the charge. The displacement of the rollers for controlling purposes is effected by rotating a hand wheel *s* connected to a bell crank lever *bb*, which is rotatable on a shaft. The other end of the bell crank lever *bb* is connected to the cages or carriers of the rollers *m*, *n*, by a rod *r*. (*Sealed.*)

GUNS AND EXPLOSIVES.

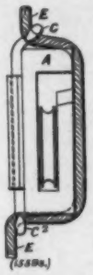
564/15. Vickers, Limited, and F. E. Smith, London. Guns. (3 *Figs.*) January 13, 1915.—The invention has particular reference to the charging or replenishing of the recuperator cylinders of ordnance and the pressure reservoir of torpedoes in circumstances in which it is inconvenient or impossible to utilise the usual plant for supplying air under pressure to these cylinders and reservoirs. According to this invention, the gas resulting from the combustion of a composition or substance in the chamber A is passed through a water or other filter B, which serves to prevent carbon or other undesirable impurities from being carried by the gas into the recuperator cylinder. This filter may also serve as a cooling device for the gas, but a separate cooling may be used. C, C represent carriers containing the cartridges of highly compressed composition, and D represents



the primer for igniting these cartridges. The combustion chamber A and the filter B are formed by the upper and lower parts respectively of a metal casing E. This casing is provided with a tube E^1 arranged co-axially within the filter B. Near its upper end this tube communicates with the combustion chamber A, and at its lower end it is normally closed by a non-return valve E^2. The combustion chamber A is provided with bosses *a*, recessed to receive the flanges *c* of the cartridge carriers C, and is threaded to receive nuts c^1, which serve to hold the cartridge carriers in position. The primer is carried in the upper end of the tube E^1, which is formed with holes *d* so arranged that the flash from the primer will be caused to impinge on the exposed portion of the combustible composition in each cartridge. The gas is conducted from the upper portion of the filter by a bent pipe e^2. (*Accepted July* 19, 1916.)

LIFTING AND HAULING APPLIANCES.

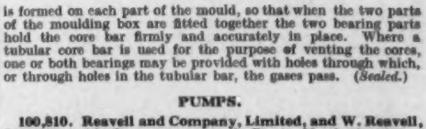
15,598/15. F. A. Bullivant, London, and A. W. L. Schermuly, Sutton. Pulleys. (2 *Figs.*) November 5, 1915.—According to this invention the pulley block A is provided with hooks C, C^2, so disposed that when the rope E, to which the pulley is attached, is engaged with the hooks, a portion of the rope will lie along one side of the pulley block and extend over



or partly over the ends thereof, so that the portion of the rope will help to support and strengthen that part of the block over which it passes. In the case of snatchblocks this strengthening effect is of especial utility, as the side of the block in which is the opening is weakened, and the rope attached to the block greatly strengthens that side. (*Sealed.*)

MINING, METALLURGY, AND METAL WORKING.

13,282/15. Humber, Limited, and J. Buchanan, Coventry. Hollow Castings. (2 *Figs.*) September 17, 1915.—This invention relates to the manufacture in pairs of complete hollow castings which require to be very accurately manufactured. According to this invention, the core bar D, which carries the coils E, F, is gripped in a bearing C. Half of the bearing C



is formed on each part of the mould, so that when the two parts of the moulding box are fitted together the two bearing parts hold the core bar firmly and accurately in place. Where a tubular core bar is used for the purpose of venting the cores, one or both bearings may be provided with holes through which, or through holes in the tubular bar, the gases pass. (*Sealed.*)

PUMPS.

100,810. Reavell and Company, Limited, and W. Reavell, Ipswich. Air Compressors. (2 *Figs.*) March 17, 1916.—According to this invention, the piston 17, which is of the solid

valveless type, has fixed in its intermediate portion a gudgeon pin 23, the projecting end portions of which are provided with rods or straps 5 and 6, respectively, which embrace eccentrics 24 fixed upon a driving shaft 3. The pedestal 1 forms the bottom end 4 of the first-stage cylinder, and is fitted with suction and delivery valves 5 and 6 respectively. 12 is the cover forming

Fig. 1.

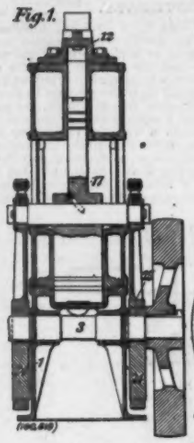
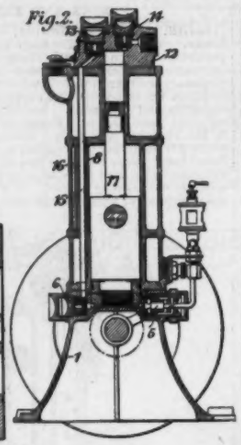


Fig. 2.



the top end of and containing the suction valve 13 and the delivery valve 14 of the second-stage cylinder; air is led from the delivery valve 6 to the suction valve 13 through a thin tube 15 that passes freely through a passage 16 formed in the metal of the liner 8, which serves as a connection between the water-jacket spaces around the two cylinders. (*Accepted July* 19, 1916.)

9,757/15. J. Keith and G. Keith, London. Rotary Blowers. (3 *Figs.*) July 5, 1915.—This invention relates to positive rotary blowers of the type comprising a spider or drum, which is eccentrically mounted in a cylinder, and to which are hinged at spaced points blade-carrying arms. According to this invention, packing strips employed are adapted to function as cup leathers, said packing strips being fitted to the spider or drum and bearing on the curved faces of the blades. The blower shown includes a spider or drum 1, on which are hinged at spaced points 2 a number of sets of arms 3, each carrying a curved blade 4. At spaced points on the external periphery of the

Fig. 1.

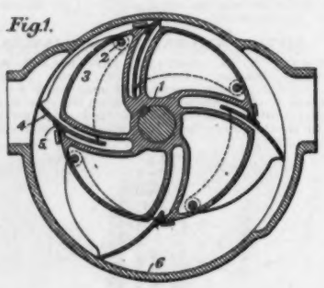
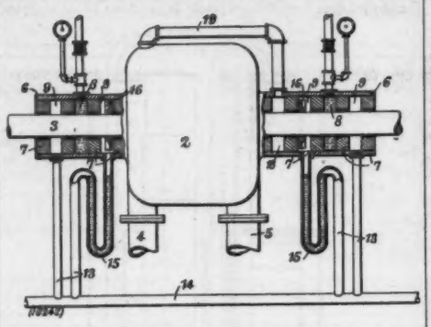


Fig. 2.

spider 1 are fitted a number of strips 5 of felt or other suitable material, with which strips the convexly-curved faces of the blades 4 are in effective contact. The edges of the blades contacting with the wall 6 of the cylinder may, if desired, be fitted with wearing strips for engagement with the internal cylindrical wall 6. With a blower constructed as described the force exerted on the blades 4 by the pressure of the fluid in front has effect merely on the hinges 2, and is not transmitted either to the cylinder or to the stationary strips 5. Further, there is no tendency for the fluid pressure to blow the blades 4 inwards no matter in what direction the blower is run (*Sealed.*)

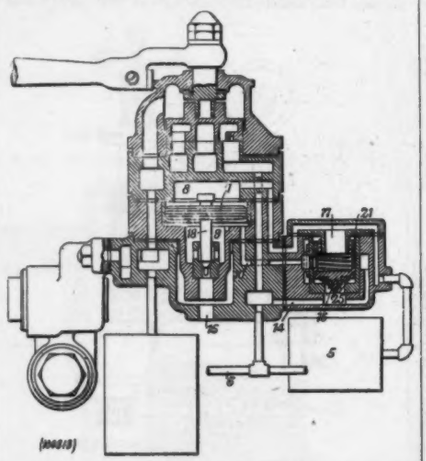
10,242/15. The British Thomson-Houston Company, Limited, London (*General Electric Company, Schenectady, U.S.A.*) **Centrifugal Compressors.** (1 *Fig.*) July 14, 1915.—The present invention relates to shaft packings and seals for centrifugal compressors. 2 indicates a centrifugal compressor having the shaft 3, inlet conduit 4, and discharge conduit 5. The packing and seal for the shaft on the inlet or low-pressure side of the compressor comprises a casing 6 surrounding the shaft and connected to the casing of the compressor. It is provided with a plurality of partition members 7 forming an intermediate chamber 8 surrounding the shaft, and one or more chambers 9 on each side thereof. The chamber 8 is connected with water under pressure. Each of the chambers 9 is provided with a drain pipe 13 connecting with a waste pipe 14, the drain pipe connecting with the chamber 9 adjacent the compressor casing being provided with a reverse bend forming a trap 15 to prevent the escape of gas. This chamber may also be provided with a small fan 16 for creating a pressure therein tending to prevent leakage from the casing of the compressor to such chamber. The edges of the partitions 7 which surround the shaft are provided with serrations or grooves which form a labyrinth packing to prevent leakage. The packing and seal on the discharge side of the compressor is the same as that on the inlet side, except that an additional chamber 18 is provided which is connected to the inlet side of the compressor by a pipe 19. This maintains chamber 18 at about the same pressure as that on the inlet side



of the machine and conducts any leakage from the casing of the compressor to such chamber back to the inlet side thereof. (*Sealed.*)

RAILWAYS AND TRAMWAYS.

100,818. The Westinghouse Brake Company, Limited, London. Fluid Pressure Brakes. (2 *Figs.*) July 13, 1915.—According to the present invention, there is provided a piston valve 16 to control communication between the train pipe 6 and chamber 9. This piston valve 16 is adapted to seal against a seat 21 in one position and against another seat 25 in its opposite position. The piston valve 16 is subject on one side to the pressure of a coil spring and to the pressure in a chamber 17, which chamber is constantly in communication with the equalising reservoir 5, and on the opposite side to train pipe pressure, which normally acts on a restricted area of the piston when on its seat 25, but has the full area exposed when the piston lifts from its seat. In operation, the equalising reservoir is charged with the train pipe as usual, and the piston valve 16 will be held on its train pipe seat 25 by the spring, since the train pipe and equalising reservoir pressures are balanced. The annular space at the lower end of the valve is preferably connected to chamber 17 so as to ensure that when the piston valve 16 is on its train pipe seat 25, the pressure in the annular space will always be equal to that in chamber 17. When the brake valve handle is moved to service



position, the preliminary exhaust port is opened and the pressure in chamber 8 and the equalising reservoir is reduced. The train pipe pressure then lifts piston 7 and uncovers the discharge valve 18, so that fluid is vented from the train pipe 6 through passage 14, ports in the piston bush, and through passage 10 to the chamber 9, and thence past the discharge valve 18 to the exhaust port 15. If the train is long, the pressure in the equalising reservoir will reduce at a faster rate than the train pipe pressure, and when a sufficient difference in pressure has been established on the piston valve 16, the valve will be shifted to its uppermost position against the seat 21. In this latter position, the valve 16 closes some of the ports between passages 10 and 14, and consequently the rate of reduction in train pipe pressure will be made slower than at the beginning of the application. When the brake valve handle is turned to lap position, after making the desired reduction in equalising reservoir pressure, fluid under pressure from the train pipe will continue to exhaust to the atmosphere through the restricted ports until the train pressure has been reduced to a point at which the equalising reservoir pressure combined with the tension of the spring acting on the valve 16, slightly exceeds the train pipe pressure, when the piston valve 16 will be moved downward to its train pipe seat 25 again, opening the rest of the ports between passages 10 and 14, so that the final exhaust of fluid from the train pipe will be at the usual rate. (*Sealed.*)

MISCELLANEOUS.

12,670/15. Head, Wrightson and Company, Limited, T. G. Wrightson and J. M. Ringquist, Thornaby-on-Tees. Fastenings for Wire Ropes. (4 *Figs.*) September 3, 1915.—

Fig. 1.

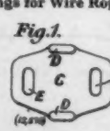


Fig. 2.

The fastening comprises two members, each consisting of a plate *c* having two lugs D and two holes E. When the members are put together the lugs of each pass through the holes of the other and are bent over. Preferably each plate is elliptical or roughly so in shape, the lugs being located at the ends of the minor and the holes near the ends of the major axis. The plates are preferably dished in order to provide space for the ropes. (*Sealed.*)

100,876. G. A. Mower and Sturtevant Engineering Company, Limited, London. Air Filters. (5 *Figs.*) March 16, 1916.—This invention relates to air filters of that character where the dust-laden air is filtered by means of suitably suspended filter bags. The valve 21 is connected by a link 24 to one end 25 of a bell-crank lever pivoted at 27 to a bracket upon the top plate 16, and the other end of this lever is connected to the extremity of a valve-operating rod 28. This rod 28 is slidable bodily, and its movement is timed by the cams 29 and 46, which are mounted upon a shaft 30 driven from the shaft 22 through gearing. The rod 28 has a depending dog 33, which operates with the cam 29, and a depending cam surface having its working surface in the same horizontal plane as that of the dog 33, which co-operates with the cam 46. The position shown in Fig. 2 is that where the dog 33 has just fallen off the highest part of the cam 29 and the projection 47 is on that point of the cam 46 where its curvature departs from the circular. This portion corresponds to the end of the filtering period and the commencement of the shaking period. The dog 34 of a cam 35 attached to the shaking cam-shaft 22 now engages the depending end 36 of the rod 28, and this rod is moved bodily to the right. This movement causes the reversal of the valve 21. The reversal of the valve, in consequence of the partial vacuum existing in the filter casing, effects a reversal of current. By this movement the rod 28 carries the shaking trigger 37, which is mounted upon a spindle 40 into position where its arm 38 is in the path of a cam

Fig. 1.

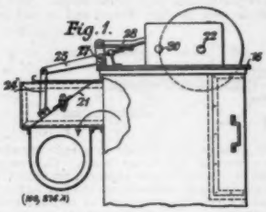


Fig. 2.

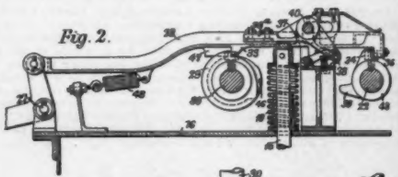
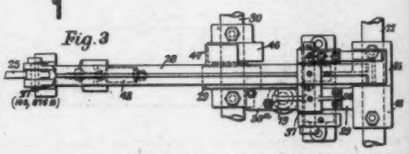


Fig. 3



dog 39 upon a cam 43. When the rod 28 has reached its extreme position, a catch 44 upon its underside will depress a spring stop and become engaged with this stop, so that the rod 28 is prevented from returning. The arm 38 of shaking trigger 37 being in the path of the cam dog 39, every revolution of the shaft 22 will cause the trigger 37 to operate, and its arm 38*a* will cause the depression of the shaking rod 15 against the influence of the spring 19, and immediately the cam dog passes clear the trigger will be suddenly released and the spring 19 will expand again and impart a jerk which will ensure the shaking of the filter bags. The cam 46 co-operates with the left-hand end of the projection 47 on the valve-operating rod 28. This cam 46 comes into operation immediately the valve-operating rod 28 has reached its extreme right-hand position, and begins to raise the rod 28. The cam is so shaped that by the time the shaking operation has been effected the rod 28 will be raised to its maximum vertical height, and the catch 44 on the rod 28 raised clear of the stop, whereupon the tension spring 48 will restore the valve-operating rod 28 and the valve 21 to normal position, the projection 47 meanwhile sliding over the cam 46 until it engages the cam with right-hand end. The dog 33 on the rod 28 will now ride upon the high part of the cam 29, and the cam 46 is so shaped that the projection 47 will be maintained clear of it while the filtering operation is proceeding; the dog 33 will then fall off the cam 29 again to the lower level, as shown in the drawings, and the projection 47 engage the cam 46, when the shaking operation will be repeated. (*Accepted July* 26, 1916.)

Guide-Vane Propellers.—Some new experiments upon propellers, provided with guide vanes in front of the screw, and not in its rear, have been conducted by Professor H. Hass and are described in the *Zeitschrift Deutscher Ingenieure* of June 24, 1916. The article deals also with the theory of the problem. The first experiments were made in a wind channel; the propeller was driven by an electric motor, and the parts were mounted in such a way that the turning moment and the thrust could be determined as well as the tangential component of the air discharged by the propeller. The subsequent tests were made on board the 17-ton boat of the firm of Theodor Zeise, of Altona. The boat in question has a length of 12 m., and is driven by 8-h.p. engines. The results were considered distinctly favourable, a higher ship's speed being attained with a smaller number of propeller revo lutions when the guide vanes were in position than when they were removed; the thrust of the "double" screw was, *e.g.*, 194 kg. when that of the single screw (without guide vanes) was 152 kg. Improved utilisation of the engine power without rise of the propeller speed would be advantageous for canal tugs in particular, where large high-speed propellers might cause damage to the canal bottom. The manœuvring capacity of the boat was not impaired by the guide vanes.